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Economic Impact Analysis of Proposed Identification and Notification Rule on Friable Asbestos Containing Materials in Schools Proposed Rule-Sec 6 Toxic Substances Control Act

Arthur Young and Co.
Washington, DC

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This study examines the economic impact of the detection and notification of schools which have areas contaminated with friable asbestos-containing materials. The problem is identified by geographic area and by square footage of asbestos-containing materials per school. Unit costs are examined by region for inspection and analysis of samples by X-ray diffraction, electron microscopy, and optical microscopy. The total impacts of Asbestos Schools Rule No. 1 are also presented and discussed. Possible courses of action for correction of the problem are also examined, which may be done voluntarily by the school or mandated by future EPA regulations.

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ECONOMIC IMPACT ANALYSIS OF PROPOSED IDENTIFICATION AND NOTIFICATION RULE ON FRIABLE ASBESTOS CONTAINING MATERIALS IN SCHOOLS

Contract No. 68-01-3930

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PREFACE

The attached document is a contractor's study done with the supervision and review of the Office of Pesticides and Toxic Substances of the U.S. Environmental Protection Agency. The purpose of the study is to analyze the economic impact of the proposed rule on identification of friable asbestos-containing materials in schools, and the notification of affected schools.

This proposed rule was prepared by the EPA Office of Pesticides and Toxic Substances to implement Section 6 of the Toxic Substances Control Act.

This report was submitted in fulfillment of Research Request Number 2 of Contract Number 68-01-3930, by Arthur Young and Company. Work was completed as of September 1980.

This report is being released and circulated at approximately the same time as publication in the Federal Register of a proposed Identification and Notification Rule on Friable Asbestos-Containing Materials in Schools under Section 6. The study is not an official EPA publication. It will be considered along with any comments received by EPA before or during the proposed rulemaking proceedings in establishing final regulations. Prior to final promulgation of this rule, the accompanying study shall have standing in any EPA proceeding or court proceeding only to the extent that it represents the views of the contractor who performed the study. It cannot be cited, referenced, or represented in any respect in any such proceedings as a statement of EPA's views regarding the subject industry or the economic impact of the regulation.

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EXECUTIVE SUMMARY

1. INTRODUCTION

This report, which is submitted in accordance with the requirements of Research Request #2, EPA Contract 68-01-3930, presents the analytical and data collection methodologies and results of work performed to date to analyze the economic impacts of EPA's proposed identification and notification rule on friable asbestos containing materials in schools.

The project was also intended to develop preliminary estimates of costs (both unit costs and costs at the school district, state and national levels), and estimates of community, financial and other impacts likely to result from voluntary corrective actions (removal, encapsulation, enclosure, etc.) that schools may opt to take. These corrective actions were originally part of a broader based EPA regulatory strategy. This strategy has since been modified to include the current proposed identification and notification rule and possibly at some future point a corrective action rule.

The estimated cost impact of the proposed rule for the nation was $25,590 for inspection; $129,169 for bulk testing using polarized light microscopy and the three test formula; $301,392 for polarized light microscopy and the seven test formula; and $232,989 and $543,190 for bulk testing with X-ray diffraction for the three test and seven test formulae respectively. A minimum of three samples is required to be taken from each sampling area. However, based on the size of the sampling area and the possible need to re-test, it has been assumed that as many as seven samples may need to be taken in some cases.

There are an estimated 5,442 school districts, 11,588 schools and 2,992,347 students affected by the proposed rule. Of the total affected public schools, 3,165 are estimated to require inspection, 2,936 will need bulk testing, and 8,545 are estimated to have exposure problems (i.e., have materials containing friable asbestos).

A risk analysis was also performed in the context of the proposed rule. Estimates of the number of students and educational staff that are at risk and that could potentially benefit from the proposed rule are as follows: students, 2,992,347; classroom teachers, 149,617; officials/administrative and non-professional workers, 104,732; professional/educational, 14,962.

2. BACKGROUND OF RULEMAKING

In December of 1978 the Environmental Defense Fund (EDF) petitioned EPA to initiate rulemaking proceedings on the issue of asbestos containing materials in schools. In March of 1979 the EPA Administration decided that a voluntary state and local technical assistance program was more opportune, and denied the petition. On July 13, 1979, as a result of a subsequent law suit by EDF, EPA initiated a rulemaking proceeding on asbestos containing materials in school buildings.

The rulemaking is based on authority contained in Section 6 of the Toxic Substances Control Act (TSCA). EPA can control chemical substances (such as friable asbestos) which present an unreasonable health risk. Under the authority of TSCA, EPA may require the survey, sampling, marking, and corrective actions of asbestos containing materials in public schools. The analysis in this report examines the effects of EPA's proposed actions pertaining to the identification of asbestos containing friable materials in schools.

3. UNIT COST ESTIMATES PERTAINING TO THE PROPOSED RULE

The methodology employed to obtain unit cost estimates of the proposed rule involved surveying various data sources, by mail and telephone, for information on cost and technical aspects of the rule, including locations of analytical laboratories, asbestos service contractors, and names of contacts who may provide additional useful data. The data sources included those persons and organizations currently involved with the school asbestos problem, i.e., EPA Regional Asbestos Coordinators, OSHA and NIOSH Offices, state occupational safety and health offices, and schools and school districts responding to EPA's Asbestos Survey Report form. Information was also obtained from analytical laboratories and firms currently offering these services.

Responses to these inquiries fell into the following four categories: those which supplied affirmative replies and seemingly reliable cost data, those which provided affirmative replies but questionable information based on the majority of responses, those which provided information regarding availability of services but not costs, and those which provided no data.

To verify data, and possibly eliminate questionable outlying points, such as those provided by contractors who obtained them from secondary sources, most respondents in the second category were recontacted. Certain limited changes that reduced the variance in the unit cost data were made in the data as a result of these calls.

Factors having an effect on the reliability and variability of the data obtained include sample size, geographical differences in labor and material costs, local availability of services and contractors, local regulations, and quality of labor and materials.

Unit costs were estimated for the various asbestos detection actions mandated by the proposed rule (inspection, and bulk testing using polarized light microscopy and x-ray diffraction). The unit costs estimated were built up from their basic components, i.e., labor, materials, operating cost, etc. The bases for these costs vary, depending on what is determined appropriate, i.e., per school, per sample, per hour or per square foot.

The estimated unit costs are summarized as follows:

(1) Costs of Inspecting School Buildings

Costs were developed on a "per school basis" and include time required for an inspection, and hourly rates of inspectors. The national average cost of performing such an inspection is $21.04 per school, based on data from 247 schools. There are large cost variations from state to state, as well as among EPA regions. This can, in part, be attributed to: insufficient sample size; profession of inspectors (inspectors included superintendents of schools, engineers, maintenance persons, school administrator, Head Start Education Director, Health Coordinator, State Public Health Specialist and architect); size of school; and geographical differences.

(2) Bulk Testing Costs

Unit costs of testing materials containing asbestos by means of polarized light microscopy and x-ray diffraction are as follows (further details are provided in Chapter V):

- Polarized Light Microscopy (PLM) Unit costs for PLM analyses are often related to the number of samples submitted and discounts are allowed for larger numbers. The unit costs include labor as well as material costs. A national average cost of $42.59 per sample was calculated.

- X-Ray Diffraction Analysis Costs (XRD) A national average cost of $70.00 per sample was estimated. Significant national and regional variations were due to a combination of insufficient sample size and outlying data points.

4. ESTIMATION OF AFFECTED SCHOOL DISTRICT POPULATION

The purpose of this task was to develop population estimates of the number and degree to which school districts, schools and students will be affected by the proposed identification and notification rule. Preliminary estimates were developed based entirely on an initial sample of respondents to the EPA Voluntary Survey. Subsequently, an analysis was conducted as to whether these preliminary estimates of school districts and schools are representative of the universe of school districts. There was concern that the method by which the original sample of school districts was chosen (including its relatively small size) introduced a bias in the results. Estimates of the number of school districts, schools and students affected were recalculated for use in subsequent total cost impact analysis of the proposed rule.

The methodological steps employed to develop the preliminary estimates are as follows:

(1) Choice of Initial Sample of EPA Returns

It was decided, based on time and resource constraints, that this project should be based on material obtained through the EPA Voluntary Survey. Of the 550 returned survey forms at the start of this study, 401 were used as the initial sample. The limitation of using these data, however, is that they may not be representative of the total population of school districts.

(2) Choice of Cluster Variables

To obtain homogeneous sets of school districts necessary for analysis, the universe of school districts was segmented into clusters. The variables chosen for segmentation were EPA region code, metro code (indicating the degree of urbanization of the school district) (MTS), number of schools built between 1945 and 1978 (NBLT), and the number of students enrolled in each school district (NST). These variables were chosen as characteristics that would likely affect the cost of compliance with the proposed rule.

(3) Cluster Analysis and Stratifications

Prior to data collection and analysis, a segmentation was required of the universe of school districts into homogeneous groups based on variables which could affect the cost of complying with the regulation. Cluster analysis was used to define suitable ranges for each variable for purposes of stratification.

(4) Bias Adjustments

Bias was suspected in the initial EPA Voluntary Sample because it was relatively small and was made smaller for this study because it was decided, based on time and budgetary constraints, to limit sample size to 250. To qualitatively test for bias, information similar to that obtained from the above respondents was collected from a sample of 20 non-respondents. Significantly, it was noted that the ranges of some of the cluster variables were restrictive resulting in the exclusion of non-respondent school districts from the established clusters. Adjustments were made to the clusters to correct for these exclusions.

(5) Data Collection

A review of the voluntary survey forms led to the conclusion that many were not complete and that the data given were not adequate to respond to the requirements of this study.

A telephone survey was conducted to obtain the necessary data from Superintendents of the school districts and maintenance personnel. A letter stating the purpose and data requirements of the survey and Sawyer's Asbestos Exposure Algorithm was sent about 10 days in advance of the phone calls. Information obtained from the school administrators indicated that, in a number of instances, the information on the EPA Survey was no longer valid. Each school district was carefully analyzed as to the completeness and accuracy of information, and when necessary, assumptions were made concerning the data.

(6) Extrapolation

For extrapolation, each sample cluster was analyzed as to the percentage of school districts, schools and students in the sample which would be affected by the proposed regulation. These percentages called "rates of affectedness" were applied to population figures for school districts, schools and students to obtain estimates of those potentially affected in the population.

Two other sets of percentages were developed for the degree to which schools and school districts in a cluster would be affected. "Degree affected" being defined as the specific corrective action needed in that school or school district.

(7) Limitations of Data

The data developed in this task have limitations which affect the reliability of the population estimates. Perhaps the most important limitation concerns the method by which sample school districts were chosen. Other limitations include the small size of the sample (which represents only 1.6% of the school district population), the probable inconsistency in the application of the asbestos exposure algorithm, and the possible data unreliability due to incomplete bulk sampling tests.

As indicated earlier, a follow-up analysis was conducted in response to the perceived data limitations. The methodological steps utilized in this follow-up analysis are discussed in this and the following paragraph. A data collection instrument was developed to provide information necessary to test for bias. Following this, a sample of non-respondents to the EPA Voluntary Survey was selected. Based on time and resource constraints, the sample size was limited to 120 randomly selected school districts. To obtain an approximately equal degree of accuracy in each cluster, the same number of sample school districts (5-6) was assigned to each cluster. Certain states were excluded from this selection process because summary returns from the EPA Voluntary Survey indicated that no school districts in these states had responded and that any attempts to sample them would be futile. All data collection was done by telephone.

To identify any important differences, the proportion of affected districts in each cluster was computed and compared to the corresponding estimate in the original study. Eight clusters were identified as having some bias. A revised set of "rates of affectedness" was computed by averaging the percentages of affected schools from the original and non-respondent samples. Based on these revised rates, revised affected population estimates were developed.

The revised population estimates for school districts and schools and students affected by the proposed rule were presented earlier. The number of affected schools adds up to more than the total as some schools will require more than one type of corrective action.

5. ESTIMATION OF TOTAL COSTS AND IMPACTS

This section presents the estimates of total costs and other impacts associated with the proposed regulation. Total costs are identified by cluster and individual asbestos control action at the school district, state, and national levels.

All cost estimates are based on the results of the two earlier tasks (unit cost estimations and estimation of affected schools and school districts). Three intermediate steps were necessary to convert the data to a form directly usable to generate total cost estimates. First unit cost estimates were transformed from the individual state level to the cluster level by weighting the state's unit cost by its frequency of occurrence in the cluster. Each state's weighted cost estimate were summed to a weighted average cost estimate for each cluster. Second, these cluster average unit cost estimates which were initially derived on the basis of differing units (per school, per sq. ft., etc.) were standardized to a common unit -- affected school district. Third, the standardized unit costs were weighted by the proportion of school districts requiring that control action to determine a modified unit cost estimate which when multiplied by the appropriate multiplier (number of school districts in a cluster by state or by nation), will generate the appropriate total cost. The specific costs of the proposed rule were provided earlier.

6. ESTIMATED COSTS AND IMPACTS PERTAINING TO VOLUNTARY CONTROL ACTIONS

As indicated earlier, preliminary estimates were developed for the cost and other impacts of various possible voluntary corrective actions that may or may not be taken. Procedures for developing these estimates were similar to those described above for the proposed rule.

The national average unit costs of corrective and related actions are as follows: $183 per sample for electron microscopy analysis (not required by the proposed rule); $37.84 per hour for taking air samples;

$36.80 and $204.64 per sample for air sample analysis using optical microscopy (NIOSH method) and electron microscopy respectively; $4.94 per square foot for removal of friable asbestos material; $0.78 per square foot for replacement of insulation following removal; $1.33 per square foot of surface removed for disposal; $2.23 per square foot for encapsulation; $4.05 per square foot for enclosure; $0.06 per square foot for marking. In general the estimates were subject to large regional variations. Data pertaining to analytical services was relatively the most reliable. The least reliable information was probably that obtained on marking as EPA had not defined specific marking requirements.

Preliminary estimates of the number of school districts that may opt to take these corrective actions are as follows: removal (which includes disposal and air quantification), 1023; marking, 1918; encapsulation, 1926; marking in boiler rooms and pipes, 3164; encapsulation in boiler room and pipe, 2502; and removal of boiler room asbestos, 126. Preliminary estimates of school districts that would have to inspect and perform bulk testing were also estimated. These were later reestimated to conform to the requirements of the proposed identification and notification rule. The modified estimates were discussed earlier.

Preliminary estimates of the national costs of these voluntary corrective actions are as follows: encapsulation, $77,744,279; removal, $48,858,648; disposal, $2,446,045; air monitoring (sampling), $334,054; air sample analysis (optical microscopy), $214,213; and air sample analysis (electron microscopy), $415,624; inspection (limited estimate), $80,642; petrographic bulk testing, $54,470; x-ray diffraction bulk testing, $83,125; and electron microscopy bulk testing, $329,340. The aggregation of these costs, utilizing the least expensive and most commonly used methods of air monitoring and bulk testing (i.e., optical microscopy and petrographic bulk testing respectively), results in a preliminary total national cost of $129.7

million. This cost may vary depending on the corrective action the schools finally opt to take. It is to be noted that in this study not all schools chose the least costly method of correction.

Other voluntary, corrective action effects that were analyzed include community and financial impacts. Twenty relatively severly impacted school districts were analyzed regarding the budget impacts of their voluntary asbestos corrective actions. Corrective cost estimates as a percentage of total capital expenditures range from 0.09% to 158.62% of total annual capital expenditures. In some school districts the cost of correcting the asbestos problems will far exceed the estimated total annual capital expenditure amount. These patterns are of concern, given the response of the majority of school administrators from this group who, when interviewed, stated that their most likely source of funding for correcting asbestos problems is the capital budget. It is also notable that, in terms of flexibility, the capital budget is relatively inflexible, especially for large dollar amounts which may require as much as a referendum.

Positive community impacts include the number of students and teachers that may be removed from the risk of asbestos exposure, and the number of jobs that may be created in the asbestos correction industry as a result of the voluntary corrective activities. Students "removed from risk" are estimated at 4,032,508; teachers "removed from risk" at 201,625; and increased employment demand at the equivalent of 5,888 person-years. It is to be noted that the last estimate would not necessarily result in that number of new jobs, because the industry as currently existing would be able to absorb a portion of this new demand.

I. INTRODUCTION

This report is submitted in accordance with the requirements of Research Request #2, EPA Contract 68-01-3930. The project was originally intended to provide economic analysis support to an initial EPA regulatory strategy that included both detection and corrective actions. This strategy has since been modified. EPA has decided to implement the detection rule (currently in the proposal stage) at this time. This may be followed at some future point by some or all of the corrective actions analyzed in this report. These corrective actions are at this time strictly voluntary and are not to be understood as contributing to the cost of the currently proposed regulation.

In the remainder of this introductory Chapter we briefly discuss the events leading to EPA's decision to regulate. We also summarize the contents of the analytical Chapters and supporting Appendices of this report.

1. BACKGROUND OF RULEMAKING

EPA initiated a rulemaking proceeding on asbestos containing materials in school buildings on July 13, 1979. This proceeding followed increasing concern by the scientific and health communities of the cancer risk due to prolonged exposure to friable asbestos-containing materials. Adding to these concerns was an EPA telephone survey done in October, 1978, which estimated that approximately 15 percent of the nation's schools contained friable asbestos to varying degrees. The series of events that led to EPA's decision to initiate rulemaking procedures are briefly discussed below.

In December 1978 the Environmental Defense Fund (a not for profit, privately supported, environmental interest group) petitioned EPA to initiate rulemaking proceedings on this issue. In March of 1979 the

EPA Administrator decided that a voluntary state and local technical assistance program was more opportune, and denied the petition. This program is intended to provide state and local school districts with an informational source and technical assistance for the inspection and correction of friable asbestos materials. The corrective actions envisioned by the program were encapsulation, removal, and enclosure. No federal funding was provided to meet the costs of corrective activities. The program included a nationwide school district survey, (hereafter called the EPA Voluntary Survey) to determine the extent of the asbestos problem in school buildings.

The Environmental Defense Fund, apparently of the opinion that the EPA technical assistance program was not adequately dealing with the school asbestos problem, sued EPA in May of 1979 to initiate rulemaking proceedings. The EPA responded by granting the petition and initiating the rulemaking of which this study is part.

The rulemaking is based on authority contained in the Toxic Substance Control Act (TSCA) under which EPA can control chemical substances (such as friable asbestos) which present an unreasonable health risk. Under the authority of TSCA, EPA may require the survey, sampling, marking, and corrective actions of asbestos-containing materials in public schools. The analysis in this report examines the cost impact of the proposed rule and the potential effects of possible voluntary correction actions pertaining to asbestos in schools.

2. FRAMEWORK OF THE REPORT

This report is divided into five Chapters and accompanying Appendices containing supportive data. Chapter I, is a brief introduction to the project and this report.

Chapter II, entitled "Unit Cost Estimates of Voluntary Individual Asbestos Corrective Actions" provides unit cost estimates developed from data obtained from asbestos sampling and analysis, and school districts which have experience with voluntary asbestos corrective work. These estimates, which were developed using the most appropriate unit for each asbestos corrective activity, are presented on a state average basis.

Chapter III, entitled "Estimation of Affected School District Population" presents the sampling methodology and results of our school district survey. In this survey, school maintenance personnel utilized the "Asbestos Assessment Algorithm" to identify the voluntary asbestos corrective activities required in their school districts. Along with the assessments, the school administrators were surveyed regarding positive and negative community impacts and the financial implications of the voluntary asbestos corrective actions in their school districts.

Chapter IV, entitled "Estimation of Total Cost and Impacts of Voluntary Asbestos Control Actions", combined the unit costs of Chapter II with the number of affected school districts and the degree to which each is affected (from Chapter III), to generate estimates of the costs of the voluntary asbestos corrective actions. In the context of these costs, potential community impacts are discussed. For twenty relatively more severely impacted school districts, a financial comparison of total voluntary asbestos control costs and annual budget items is presented. The chapter concludes with a summary of available funding and assistance for local school districts at various levels of government.

Chapter V, entitled "Cost of Proposed Identification and Notification Rule", presents the results of work performed to expand and refine the original cost and affected population estimates, in order to tailor them to the requirements of the proposed identification and notification rule.

Chapter VI, entitled "Summary", presents the costs of the proposed rule estimated from the results of the surveys and analyses.

Appendix A contains project estimates of the average amount of asbestos (in square feet) per affected school district in each cluster. Appendix B contains tabulations by cluster of costs for each corrective action aggregated to the state level. Appendix C is a detailed listing of affected (and potentially affected) schools and students in the New York City Public School System. This appendix also contains estimates of asbestos square footage by school. Appendix D contains copies of the various data collection instruments used in this project. A copy of the draft version of Asbestos Exposure Assessment Algorithm utilized in this project is submitted as Appendix E.

II. UNIT COST ESTIMATES OF VOLUNTARY INDIVIDUAL ASBESTOS CORRECTIVE ACTIONS

The purpose of this task was to estimate unit costs of various control activities which may be used to control asbestos in school buildings, and to determine the availability of such services to the schools and school districts. With the exception of some of the detection actions, all other control actions are strictly voluntary at this time. The voluntary asbestos control activities include the following:

- Inspection of school buildings for friable materials
- Analysis of bulk samples for asbestos
- Asbestos removal
- Asbestos disposal
- Encapsulation or enclosure
- Quantification of airborne asbestos
- Marking of areas in which removal is not warranted

1. DATA COLLECTION METHODOLOGY

(1) Data Sources

Information was requested from sources which are currently involved with the school asbestos problem, including sources which have had experience with asbestos, albeit in areas other than schools, and sources which are capable of providing such services but have not yet done so.

The approach adopted was to first contact all EPA Regional Asbestos Coordinators by phone to inform them of the intent of the data search and the type of information being sought. This was followed by a letter requesting the coordinators to provide whatever cost and other technical information they may have on the above-mentioned control activities. Other information requested included locations of analytical laboratories, asbestos service contractors, and names of contacts who may provide additional useful data.

Letters were sent to other government agencies as well to determine if they could provide relevant information based on their experience. These agencies included OSHA regional and area offices, state occupational safety and health offices, state environmental agencies, and regional NIOSH offices.

To obtain costs of surveying schools for friable materials and to obtain specific details on schools' experiences with contracted services, letters of inquiry were mailed to schools and school districts. The information requested included the following:

- Number of students in each school surveyed
- Square footage of each school surveyed
- Amount of time spent surveying at each school
- Hourly rate of person performing survey

- Cost of bulk sample analysis (if applicable) and name, address, and phone number of laboratory
- Information on removal, encapsulation, or enclosure (if performed) and performing contractor.

The source of this mailing list was those school districts which had responded to the EPA Asbestos Survey Report (Form OMB No. 158-R-0165) as of November 19, 1979. These responses were provided by EPA.

Other sources of information to whom letters of inquiry were sent include analytical laboratories, contractors providing air monitoring services, and firms involved with removal, encapsulation, enclosure, disposal, or marking. These letters specifically asked for unit cost estimates for:

- Bulk sample analysis for asbestos by polarized light microscopy, X-ray diffraction, and electron microscopy
- In-school air monitoring for asbestos
- Air sample filter analysis by optical microscopy (NIOSH method) and electron microscopy
- Removal of asbestos materials under EPA and OSHA approved methods
- Disposal of asbestos materials removed by EPA approved methods
- Encapsulation of asbestos materials in conformance with applicable EPA and OSHA regulations
- Enclosure of asbestos materials in conformance with applicable EPA and OSHA regulations

- Marking of areas containing asbestos.

These firms were identified through lists provided by the above government agencies and schools, company names obtained through trade associations (such as the National Insulation Contractors' Association), professional association consultant listings (American Industrial Hygiene Association, Air Pollution Control Association), listings and advertisements in technical publications (Environmental Science and Technology, Pollution Engineering, Analytical Chemistry Engineering) and personal contacts.

(2) Responses and Data Verification

Most information was obtained by mail correspondence since this was the simplest means for reaching the largest number of people in a short period of time. In all, a total of 395 letters were sent to schools and school districts with an 18 percent response, and 646 letters to laboratories, contractors and consultants with a 30 percent response.

The responses fell into four categories:

- Those which supplied affirmative replies and seemingly reliable cost data
- Those which provided affirmative replies but questionable information based on the majority of responses.
- Those which provided information regarding availability of services but not costs
- Those which provided no data since they had no involvement with asbestos services or were unaware of their availability.

To verify data, a small number of respondents selected at random from category one were called to discuss information submitted. No changes were made as a result of these phone calls. Calls were made to most respondents in category two, but even here very few changes were made in data received. A few phone calls were made to respondents in category three, but no additional information was obtained, especially from contractors who felt that costs vary so widely that a reasonable estimate was impossible without consideration of a specific case.

Specific limitations of information received and the resulting regional and national cost estimates are discussed in the next section.

2. DATA LIMITATIONS

In general, the best information obtained was that related to analytical services. This is true because analytical methods are standard in most cases, and this makes the particular service, and thus the unit cost, very specific. On the other extreme, the least reliable information was probably that obtained on marking of areas containing asbestos. At the time of the cost survey, EPA had not yet defined its specific marking requirements. Thus the size and type of label, number required, etc., were not delineated when information on marking was requested.

The unit costs for the other voluntary control activities fall in between these two extremes. An example is encapsulation. If a specific site could be defined, with a certain size, location, surface configuration, amount of required encapsulating material, etc., then unit costs could be estimated in much the same manner as quoting a price for performing a certain analytical procedure. However, without this specificity, cost estimates can be expected to vary considerably.

Other factors having an affect on the reliability and variability of the data include sample size, geographical differences in labor and material costs, local availability of services and contractors, local regulations, and quality of labor and materials.

3. UNIT COSTS

Unit costs were estimated for detection, the voluntary removal and disposal of asbestos in school buildings, other voluntary methods of asbestos control, and for marking of areas of asbestos containing materials. The unit costs estimated were built up from their basic components, i.e., labor, materials, operating cost, etc. The bases for these costs vary, depending on what is determined to be more appropriate:

- Per School, for costs of inspection of school buildings
- Per Sample, for costs of bulk testing of materials suspected of containing asbestos by means of polarized light microscopy, X-ray diffraction, and electron microscopy
- Per Hour, for costs of air monitoring in school buildings containing asbestos
- Per Sample, for costs of air filter sample analyses by means of optical microscopy (NIOSH method) and electron microscopy
- Per Square Foot, for removal, disposal, encapsulation, enclosure, and marking of areas containing asbestos.

To show geographical variations, costs are broken down by the ten EPA regions and by states within the regions.

The following statistical parameters are used in presenting the unit costs:

- Mean (or average), $\bar{X}$
- Sample size, n
- Standard deviation, s
- Range, R.

The mean, $\bar{X}$, is the average of the sample (assumed to be random). It is the quantity that best estimates the average of a population from which this sample was drawn. Mathematically, $\bar{X}$ is $\Sigma X_i/n (i=1,2,3...n)$ where X_i represent individual costs reported by the schools, laboratories, or contractors.

Sample size, n, indicates the number of schools, or laboratories, or contractors, which responded to our cost survey and gave affirmative cost information.

Standard deviation for an entire population is the square root of population variance, σ^2 . The estimate for mean has a variance equal to the variance of the individual costs divided by n. The estimate of variance, s^2, is $\sum_{i=1}^{n} (X_i-\bar{X})^2/n$ where n is the sample size, X_i is the individual cost, and $\bar{X}$ is the average of a sample. The square root of s^2, s, is the estimate of standard deviation.

Range, R, is a simple measure of dispersion. It is the difference between the largest and the smallest cost in a sample.

Regional variation is obtained by computing the coefficient of variation (CV). The calculation steps are as follows:

- Compute the national average (grand mean) from the regional averages (individual means), i.e. $\bar{\bar{X}} = \sum_{i=1}^{n} \bar{X}_i/n$, where $\bar{X}_i = \bar{X}_1$, $\bar{X}_2$, etc., and $n = 10$ in most instances.

- Compute the standard deviation: $S = \sqrt{(\Sigma\bar{X}_i - \bar{\bar{X}})^2/n}$

- Compute the coefficient of variation: $CV = (s/\bar{\bar{X}})(100\%)$.

The unit costs estimated for the asbestos control activities of interest are presented in Tables 1 to 13. The data in these tables were developed by performing the following computations:

- The sample mean, standard deviation, and range for each state were calculated from the data received from that state.

- The sample mean, standard deviation, and range for each region were calculated from the data received from all states within that region.

- The sample mean, standard deviation, and range for the entire United States were calculated from the data received from all states within all regions.

The coefficient of variation among states nationally is discussed in the text below. It is calculated, as noted above, by dividing the national standard deviation by the national mean.

Table 14 shows the availability of all pertinent services by region and state.

In the following paragraphs, unit costs are summarized showing elements of these costs wherever possible, and a discussion is presented of the extent of variation, cost trends, data limitations, etc.

(1) Costs of Inspecting School Buildings

Table 1 summarizes the unit costs of inspection of school buildings for friable material. This summary was developed from information supplied by schools and school districts.

Data provided by schools included time required for an inspection, hourly rates of inspectors, and total square footage of schools inspected. Unit costs were initially developed on a "per square foot" basis. However, variations were found to be considerable, producing a national standard deviation of more than twice the mean. This was mainly due to the fact that estimated inspection times for smaller schools tended to approach those of larger schools. Costs on a "per school basis," although still variable, provide a more reasonable basis for discussion.

The national average cost of performing such an inspection is $21.04 per school based on data from 247 schools; the standard deviation is $19.51. No schools from Regions I and II were used in this computation because of lack of information from states in these regions. This may have caused a bias in the national estimates. Region IX had the highest rate for inspections at $92.20 per school; this was due to high rates reported in the state of Arizona. Consistently low reported rates in Region III gave this region the lowest average inspection rate at $14.39 per school. All other regions, with the exception of Region VIII, had unit inspection costs comparable with the national average.

Unit costs for the inspection of school buildings include only labor costs since no specialized equipment is required to perform the inspections. The per school costs were obtained by multiplying the hours spent on each survey by the hourly salary rates of those who performed the surveys. For example, in the state of Alabama, one inspector spent three hours to inspect a school having 9,522 square feet. His hourly pay was $10.00, resulting in a unit cost of $30.00 per school. In a large school (540,000 sq. feet) in Arizona, an inspector paid at $7.80 an hour spent 20 hours making an inspection. This produced a unit cost of $156.00 per school, the highest in the nation.

No regional trends are discernable from the cost data in Table 1. However, there are large cost variations from state to state (CV=92.73%) as well as among regions (CV=91.77%). The reasons for these variations include:

- Insufficient Sample Size. Obviously, a small number of samples tend to make the sample's distribution shift away from normal. In other words, a small number of samples may represent the extremes of a population. The individual costs reported in Region IX are an example of this.

- Profession of Inspectors. According to our survey, the professions of those who inspected school buildings include, but are not limited to:

    - Superintendent of School

    - Engineer

    - Maintenance Person

    - School Administrator

    - Head Start Education Director

    - Health Coordinator

- State Public Health Specialist
- Architect

The hourly rates of these professionals are so variable that the unit costs estimated vary significantly on this basis.

- Size of School. The size of schools inspected vary from a small rural Head Start Center (483 square feet) in North Carolina to a large high school (540,000 square feet) in Arizona. This variation affects the number of hours spent by an inspector in determining the presence of friable material. This, along with the difference in hours spent for school inspection, compounds the variation in unit costs.
- Geographical Differences. The data obtained did not show significant differences between industrial and agricultural states. The reason for this is probably due to a lack of sufficient sample size from both areas.

(2) Bulk Testing Costs

The unit costs of testing materials suspected of containing asbestos by means of polarized light microscopy, X-ray diffraction, and electron microscopy were determined from cost information collected from laboratories which responded to our survey (Table 2 to Table 4). As shown in the tables, polarized light microscopy (PLM) is the least expensive analytical technique for bulk sample asbestos analysis and is the standard test recommended by EPA. Electron microscopy (EM) is the most expensive and least available method and is generally not recommended by EPA for these reasons. X-ray diffraction (XRD), a technique commonly used as a back up technique to amplify analytical data obtained by polarized light microscopy, had a unit cost between PLM and EM. Cost data for these three analytical methods are discussed below.

- Polarized Light Microscopy Analysis Costs

Eighty-seven laboratories around the nation provided a positive response to our inquiry. A national average of $54.14 per sample was calculated with a range of $10.00 to $300.00 per sample (Table 2).

Unit costs for PLM analyses are often related to the number of samples submitted. Discounts are allowed for larger numbers. For example if more than one sample is submitted, a 10% discount is usually offered by most laboratories. Some laboratories offer as high as 50 percent discounts if more than 100 samples are submitted. Other laboratories set their unit price per sample on a minimum number of samples submitted, e.g. four. Whatever the cost, the unit costs include labor as well as material costs.

The coefficient of variation for the entire nation is 83.78% while that for the regions is 57.65%. The high variations from state-to-state as well as from the region are mainly due to a few out lying values, i.e. $10.00 (North Carolina), $300.00 (Ohio), and $250.00 (Nebraska). If these values are excluded from the computation, the CV for the nation is 61.77% and the CV for the region is 23.10%.

- X-Ray Diffraction Analysis Costs

Table 3 summarizes the unit costs of testing friable materials for asbestos by X-ray diffraction. A national average of $78.05 per sample was estimated from 64 laboratories. The comparison of the regional average costs per sample indicated that Region VIII has the highest cost, $150 (two laboratories) while Region V shows the lowest cost, $51.54 (13 laboratories).

As in PLM analyses, unit costs for XRD are dependent on the number of samples submitted. Discount ranges from 10% to 30% on increasing number of samples. Costs include the cost for labor as well as materials used in the laboratory.

There are significant national (coefficient of variation = 55.64%) as well as regional variations (CV=37.23%). These are due to a combination of insufficient sample size and outlying costs. For example, per sample costs greater than $200 were reported in the states of Connecticut, Louisiana and Missouri. In each case the sample size was three or less. For Region VII, only two cost estimates were received, averaging $150 per sample.

- Electron Microscopy Analysis Costs

The per sample costs of testing friable materials for asbestos by electron microscopy are presented in Table 4. A total of 28 laboratories provided cost information from which a national average of $169.73 per sample was estimated. The per sample cost ranges from $75 in Colorado to $350 in Illinois.

Unlike PLM and XRD analyses, the number of samples submitted for EM analysis does not necessarily alter the unit costs. Only a few laboratories indicated that discounts would be offered if more than three to five samples were submitted. The reason for a fixed unit cost for EM analyses is that EM is costly, time consuming, and limited in availability. As with the other analyses, each unit cost includes the cost for labor, material, and other expenses which are required to perform the test.

A coefficient of variation (CV) of 50.32% represents the variation from state-to-state across the nation, while a CV of 36.95% indicates the variation from region to region. These variations are again probably due to inadequate sampling as well as insufficient sample size. An important note regarding sample size here is that, since availability of EM analysis is rather limited, the sample size is unavoidably small.

(3) Costs of Air Quantification

Air quantification is voluntary and includes the cost of monitoring in school buildings (Table 5), the cost of analyses of samples through optical microscopy (NIOSH method) (Table 6), and the cost of sample analysis using electron microscopy (Table 7). These cost estimates are discussed separately below.

- **Cost of Air Monitoring**

Table 5 presents hourly costs of monitoring air in school buildings for airborne asbestos. An average cost per hour for the nation is $37.84 with a standard deviation of $18.14, estimated from 77 laboratories and/or contractors. The lowest hourly rate, $7.87 per hour, was found in Wyoming, while the highest hourly rate, $80.00 per hour was found in Illinois.

The hourly cost includes labor and overhead costs for activities involved in in-school air monitoring. This cost does not include travel expenses, per diem, equipment rental, etc.

Travel expenses include air fare (usually actual + 10%), bus or train fare (actual + 10%), car rental or use of private vehicles ($0.20-$0.25 per mile). Per diem includes lodging and meals (actual + 10%).

Use of monitoring equipment would normally be included in hourly rates. However, if a contractor needs to rent air sampling pumps, an additional cost of approximately $15-20 per week per unit may be incurred. Other minor items that may be charged separately include disposable respirators (about $1.00 each), protective disposable coveralls (about $3.00 each), and air sampling filters (about $1.25 each, $2.50 with cassette holder).

The coefficients of variation in hourly air monitoring costs are 47.94% among states nationally and 31.89% among regions. Factors which affect hourly costs include:

- Level of professionals actually performing the work. For instance, one contractor in Massachusetts provided the following details:
    - Certified Industrial Hygienist $55.00/hr.
    - Industrial Hygienist $37.50/hr.
    - Industrial Hygiene Technician $27.50/hr.
- Availability of laboratories or contractors. Local availability of contractors would dictate lower costs since competition normally drives prices down.

In addition to the above, costs may seem to vary inordinately due to inadequate sampling size.

Overall costs for a particular monitoring job would depend on a combination of the overall time spent and the hourly rate for a particular level of person. Factors requiring time include preparation for monitoring, travel time, actual monitoring time, and report writing.

• Costs of Air Filter Sample Analyses by Optical Microscopy (NIOSH Method)

The costs of analyses of asbestos air samples by optical microscopy (NIOSH Method) are summarized in Table 6. A national average of $48.25 per sample with a standard deviation of $42.92 was estimated from 98 laboratories.

The unit cost includes the cost of labor and materials. As in other analytical costs, discounts may be allowed depending on the number of samples delivered for analysis.

State-to-state variation was found to be represented by a coefficient of variation of 88.95%. The coefficient of variation among regions is 43.35%. It is difficult to explain the large variations in this case since optical microscopy has become such a standardized test for asbestos air sample analysis.

• Costs of Air Filter Sample Analyses by Electron Microscopy

Table 7 summarizes the costs of analyses of asbestos air samples by electron microscopy. The cost per sample ranges from $50.00 in Missouri to $400.00 in Louisiana. These costs give a national average of $189.43 with a standard deviation of $106.17. Each unit cost includes labor as well as material costs.

The variation in state means is indicated by a coefficient of variation of 56.05% while the variation among the regions is shown by a coefficient of variation of 45.48%. The large variations are likely due to insufficient sample size.

(4) Cost of Removal

Table 8 summarizes the potential costs for the voluntary removal of friable asbestos. A national average of $4.94 per square foot of friable asbestos was estimated from the cost information provided by 32 contractors. The unit cost for removal ranges from $1.00 per square foot in Pennsylvania to $13.75 per square foot in Missouri. Removal costs consist primarily of labor costs.

The coefficient of variation among states is 53.04% and that among the regions is 46.34%. Statistically, these variations are caused by inadequate samplings (two extremes: $1.00 per square foot and $13.75 per squre foot) and insufficient sample size, i.e., only 32 contractors were willing to estimate costs. In addition, a few practical factors which determine the variation in costs of removal are:

- Geographical location of schools. For example, a contractor headquartered in Connecticut costs removal service in neighboring states at the following rates:
    - Connecticut - $2.00/ per square foot
    - Northern New Jersey - $4.00/ per square foot

  - Southern New York - $4.00/ per square foot

  - Southern Rhode Island - $3.00 per square foot

- Extent of removal. For example, in North Carolina, total removal of asbestos costs $5.00/ per square foot while partial removal costs $3.50/ per square foot.

- The nature of structures on which asbestos is found. For example, in Florida, $2.50 per square foot is estimated if a flat concrete ceiling is involved while $14.00 per square foot is estimted if bar joists and corrugated metal deckings are involved.

(5) Cost of Disposal

Table 9 summarizes the potential costs of disposal of friable asbestos materials if removal is performed. The average cost for the nation is $0.33 per square foot of surface removed. This was computed from cost information provided by 19 contractors. The unit cost of disposal ranges from a penny per square foot in Pennsylvania to $1.55 per square foot in Maryland. (The latter price includes cost of marking of asbestos waste.)

The cost of disposal of asbestos waste estimated by each contractor includes labor and landfill costs only, and does not include the cost of transportation. Transportation costs can be expected to vary greatly. In Pennsylvania, one contractor estimated $120.00-150.00 charge per hauling run.

The data in this table are of questionable reliability due to the low number of replies. Information was received from only fifteen states, and of these there was only one reply from each of thirteen states.

Based on information received in letters and from discussions over the phone, various states are unclear on how to categorize asbestos wastes. Due to prevailing indecision at the state level, there was much hesitation on the part of contractors to quote costs.

(6) Encapsulation Costs

The per square foot costs of voluntary encapsulation of asbestos containing materials are presented in Table 10. A national average of $2.23 per square foot with a standard deviation of $1.06 was estimated from the cost information provided from 37 contractors.

The estimated unit cost of encapsulation of materials containing asbestos includes labor as well as encapsulation materials. The encapsulating material is commercially called "penetrating sealant." Four EPA-tested products for encapsulation are: Cafco Bond Seal by U.S. Mineral Products, Forester 32-20 and 32-21 by H.B. Fuller Company, Decadex Firecheck by Pentagon Plastics, and K-13 by National Cellulose. These products are sold at the following prices:

- Decadex Firecheck - this bridging sealant costs $19.00 per gallon in Washington State. Each gallon of sealant covers approximately 70 square foot of surface; when applied, this amounts to a cost of about $0.27/ per square foot.

- Forester Products - Its product is 554-21-1 penetrating sealant. In Houston, Texas prices for 55 gallon drums are: $4.50 per gallon (if 1 to 19 drums are purchased), $3.80 per gallon (20 to 79 drums), and $3.55 per gallon (80 or more drums). Approximately 14 gallons of this sealant cover 100 square foot of 1-inch thickness of surface. If 1/2-inch thickness is applied, 7 gallons cover 100 square feet and cost about $0.63/ per square foot.

- Cafco Bond Seal - A contractor in Washington State quoted a cost of $0.25 per square foot when applied in a one-inch thickness. The pricing for sealant and labor ranges from $0.75 to $1.50 per square foot in this same state.

- K-13 - The cost, in Houston, Texas, of K-13 runs 12-1/2 to 21 cents per board foot (12"by 12" square, one-inch thick, applied) depending on color. Total cost of encapsulation ranges from $1.00 to $3.00 per square foot.

Variation in costs per square foot among states is represented by a coefficient of variation of 47.53%. Among regions, the coefficient of variation is 39.98%. These variations are most likely due to the following factors:

- Type of sealants applied. As previously discussed, the costs vary from one sealant to another. For example, use of Forester 554-21-1 costs $0.63 cents per square foot while use of Decadex Firecheck costs 27 cents per square foot.

- Geographical location of schools. By encapsulating with K-13 sealant, the same contractor estimates $1.50-2.50 per square foot in Georgia compared to $1.00-2.00 per square foot in Tennessee.

- Nature of structures for encapsulation. In Indiana, one contractor estimates $3.25 per linear foot for piping and $0.80 per square foot for walls and ceilings.

- OSHA workplace regulations. For example, in Texas, one contractor set pricing on encapsulation work with K-13 sealant according to the OSHA standard on airborne asbestos fiber count. If the air fiber count in the area to be encapsulated is below this standard, an estimate of $1.50 per square foot was quoted; if the count is above the standard, the price quoted was $2.50 per square foot.

(7) Cost of Enclosure

Costs per square foot of voluntarily enclosing asbestos containing materials are summarized in Table 11. A national average of $4.05 per square foot with a standard deviation of $1.62 per square foot was estimated. Some states in Regions III and VIII have services available, but no estimation of costs was provided by contractors. In Region X, no information on availability or cost of enclosure services was obtained.

For enclosure, a barrier such as a suspended ceiling may be constructed between the asbestos material and the building environment. The unit cost of this construction work includes the labor cost as well as material cost. The material used for a barrier construction may include a lathe system for a ceiling, the ceiling material, and protective equipment for construction personnel. A large variety of enclosure materials are on the market; no attempt was made to describe and price these individually.

The variations among states and regions are represented by coefficient of variations of 40% and 27.61% respectively. Insufficient sample size may statistically cause these variations. Other causes are the following:

- Hourly rate of laborers (construction personnel). This should relate to geographical location of contractors

- Quality and type of ceiling materials used

- Manner in which a ceiling is to be constructed

- Geographical location of schools relative to contractors (travel costs).

(8) Cost of Marking

At the discretion of the school or school district areas of friable asbestos containing materials may be marked. A national average of $0.06 per square foot of area required to be marked was estimated from nine contractors (Table 12). In the states of Indiana and Michigan, hourly rates of $25.00 and $40.00 were estimated for providing marking services. Many contractors in fourteen states (Regions I, II, III, VIII, and IX) stated they would provide marking services, but no costs were given. In Region X, no contractors indicated the availability of this service.

Cost of marking includes labor as well as material costs. Travel is an additional cost which depends primarily on the distance between the contractor and school. In Ohio, mounting a metal urethane coated sign was quoted as costing $15.00 (plus travel expenses). If labels are used, one variable is the type of label (See Exhibits 1 and 2). Prices range from 17.6 to 25 cents per label. In New York City, a "STOP SIGN" label (See Exhibit 3) is used to apply to walls or ceiling surfaces.

Because of the small sample size, no coefficients of variation were computed to estimate the variations among states and regions. The variations in costs of marking would be influenced by the following factors:

- Type and size of sign (metal, cardboard, paper label)

- Manner of fixation (posting, bolting, tieing, self-adhesive)
- Location (doors, walls, ceilings, etc.)
- Size of areas requiring to be marked.

Costs also vary depending upon who applies the signs. If done by school personnel, costs would be minimal. If done by a contractor, the costs would be higher because of travel considerations and high professional hourly rates.

(9) Cost of Replacement of Insulation After Asbestos Removal

Any asbestos containing materials which are removed, must be replaced. The unit replacement costs were obtained on a per square foot basis by contacting companies by telephone that provided encapsulation costs. These unit costs include both labor and material costs. Replacement costs in general are a function of the hourly rate of labor, material costs and degree of difficulty involved in placing the insulation.

Costs per square foot for insulation replacement are summarized in Table 13. A national average cost of $0.78 per square foot was obtained on the basis of information provided by 35 contractors in 22 states. The standard deviation was $0.33 per square foot. These figures are per inch thickness of insulating material.

No information was obtained from 15 states while 12 others indicated the availability of contractor services without providing estimates of costs.

(10) Regional Availability of Services

Table 14 is a list of contractors and the services they provide. The list is broken down by region and state. Table 15 summarizes this information, providing the number of respondents from each region able to provide a particular service and the percentage of the total that the number represents.

With regard to bulk testing analysis, Region V has more services available than any other region. Region VI stands in second place, while Region X provides the least number of available services

In regard to air monitoring and air sample quantification, Region V still has more available services, while Region X has the least available services on the whole.

Concerning the voluntary control of asbestos in school buildings, Region VI has the highest availability of all services (removal, disposal, encapsulation, enclosure, and marking), Region VIII has the least availability in removal, disposal, and encapsulation service. Region X shows no availability of enclosure and marking services.

EXHIBIT 1

ORDER STOCK NO. 553-22 FROM
THE HCL® COMPANY, P.O. BOX 539, MENLO PARK, CA 94025

CAUTION

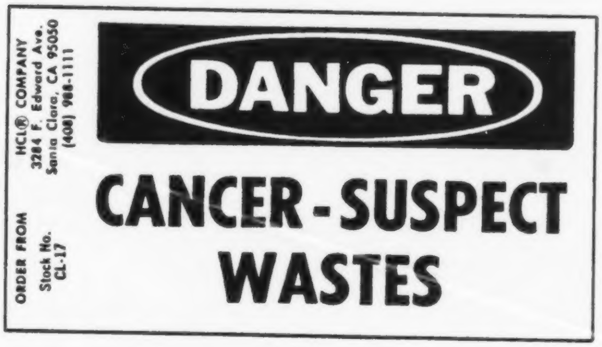
CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
BREATHING ASBESTOS DUST MAY CAUSE
SERIOUS BODILY HARM

ORDER STOCK NO. CL-18
THE HCL® COMPANY, P.O. BOX 539, MENLO PARK, CA 94025

CAUTION

REGULATED AREA
CANCER - SUSPECT AGENT(S)
AUTHORIZED PERSONNEL ONLY

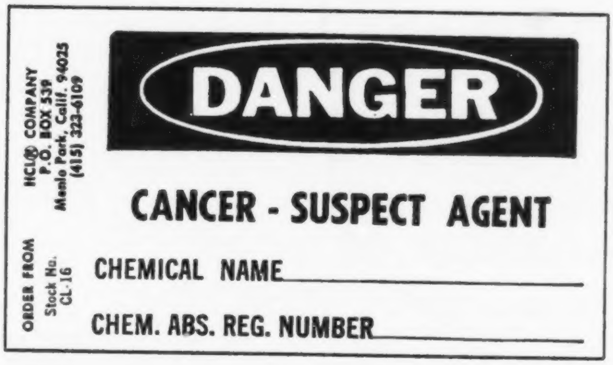
EXHIBIT 2



ORDER FROM HCL® COMPANY
3284 F. Edward Ave.
Santa Clara, CA 95050
(408) 988-1111
Stock No. CL-17

DANGER

CANCER-SUSPECT WASTES



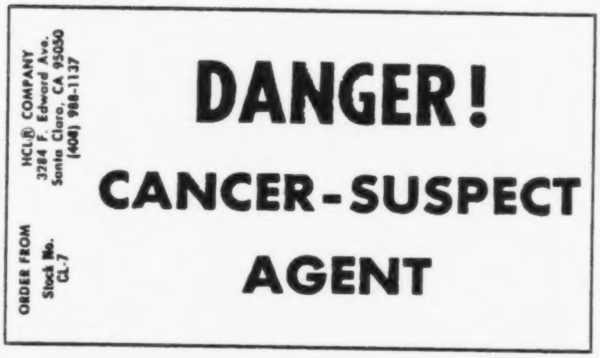
ORDER FROM HCL® COMPANY
P.O. BOX 539
Menlo Park, Calif. 94025
(415) 323-6109
Stock No. CL-16

DANGER

CANCER - SUSPECT AGENT

CHEMICAL NAME____________________

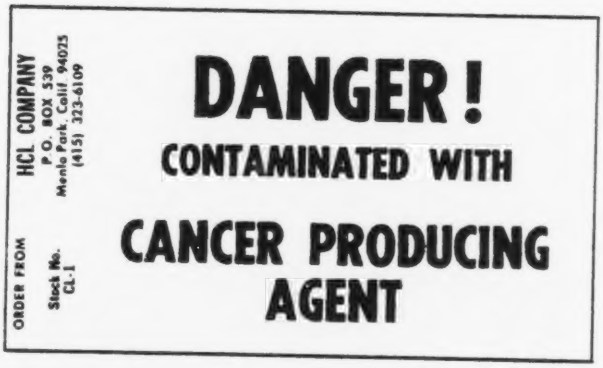
CHEM. ABS. REG. NUMBER____________________



ORDER FROM HCL® COMPANY
3284 F. Edward Ave.
Santa Clara, CA 95050
(408) 988-1137
Stock No. CL-7

DANGER!

CANCER-SUSPECT AGENT

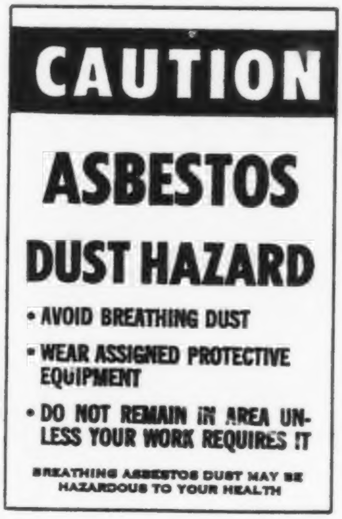


ORDER FROM HCL COMPANY
P.O. BOX 539
Menlo Park, Calif. 94025
(415) 323-6109
Stock No. CL-1

DANGER!

CONTAMINATED WITH

CANCER PRODUCING AGENT



CAUTION

ASBESTOS

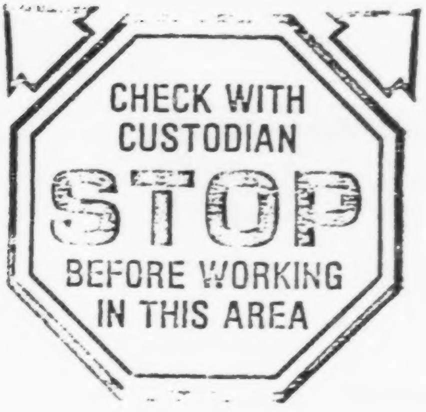
DUST HAZARD

- AVOID BREATHING DUST
- WEAR ASSIGNED PROTECTIVE EQUIPMENT
- DO NOT REMAIN IN AREA UNLESS YOUR WORK REQUIRES IT

BREATHING ASBESTOS DUST MAY BE HAZARDOUS TO YOUR HEALTH

EXHIBIT 3

NYC's WARNING SIGN


CHECK WITH
CUSTODIAN
STOP
BEFORE WORKING
IN THIS AREA

"STOP SIGN" labels are to be applied to wall or ceiling surfaces at prescribed intervals. We use twenty (20) feet. In corridors, they are placed at twenty feet on each facing wall, staggered.

Arrows are placed to direct attention to the actual location of the asbestos containing material. They can point in any of the eight directions.

TABLE 1

COSTS PER SCHOOL OF INSPECTING SCHOOL BUILDINGS FOR FRIABLE MATERIALS

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	a		
Maine	a		
Massachusetts	a		
New Hampshire	a		
Rhode Island	a		
Vermont	a		
All Region I			
Region II:			
New Jersey	a		
New York	a		
All Region II			
Region III:			
Delaware			
Dist. of Columbia	$ 30.00 (5)	0	(30.00-30.00)
Maryland			
Pennsylvania	14.40 (13)	± 5.59	(6.58-23.40)
Virginia	9.79 (17)	± 3.27	(4.50-18.00)
West Virginia			
All Region III	14.39 (35)	± 7.90	(4.50-30.00)
Region IV:			
Alabama	18.35 (4)	± 8.45	(10.00-30.00)
Florida	103.63 (2)	±30.22	(82.26-125.00)
Georgia	18.36 (17)	±11.72	(9.20-37.20)
Kentucky	23.72 (31)	±15.45	(16.00-80.00)
Mississippi	10.33 (3)	± 4.04	(8.00-15.00)
North Carolina	11.28 (25)	± 8.62	(3.36-22.42)
South Carolina			
Tennesse			
All Region IV	20.01 (82)	±18.91	(3.36-125.00)
Region V:			
Illinois	26.00 (2)	±19.00	(12.00-40.00)
Indiana			
Michigan	19.55 (12)	±13.21	(8.00-40.00)
Minnesota	49.30 (5)	±34.21	(8.50-85.00)
Ohio	35.00 (8)	±10.61	(27.50-42.50)
Wisconsin			
All Region V	30.11 (27)	±20.00	(8.00-85.00)
Region VI:			
Arkansas			
Louisiana	64.00 (1)		
New Mexico	9.57 (4)	± 4.21	(4.51-14.34)
Oklahoma	16.47 (7)	± 9.14	(9.61-28.83)
Texas	22.48 (6)	±13.85	(6.25-39.12)
All Region VI	24.58 (18)	±24.08	(4.51-39.12)
Region VII:			
Iowa	12.89 (43)	± 3.32	(12.05-24.10)
Kansas	36.25 (6)	±10.76	(23.41-54.63)
Missouri	5.50 (3)	0	(5.50- 5.50)
Nebraska			
All Region VII	15.16 (52)	± 9.02	(5.50-54.63)

TABLE I

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado			
Montana	$ 12.00 (1)		
North Dakota			
South Dakota			
Utah			
Wyoming			
All Region VIII	12.00 (1)		
Region IX:			
Arizona	106.67 (3)	±42.77	(80.00-156.00)
California	48.80 (1)		
Hawaii			
Nevada			
All Region IX	92.20 (4)	±45.35	(48.80-156.00)
Region X:			
Alaska			
Idaho			
Oregon			
Washington	25.61 (28)	±20.35	(5.00-90.00)
All Region X	25.61 (28)	±20.35	(5.00-90.00)
All Nation	21.04 (247)	±19.51	(3.36-156.00)

a. No information obtained from Regions I and II.

TABLE 2

COSTS PER SAMPLE OF TESTING FRIABLE MATERIALS FOR ASBESTOS BY POLARIZED LIGHT MICROSCOPY

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	$ 95.00 (2)	±77.78	(40.00- 50.00)
Maine	a		
Massachusetts	47.60 (5)	±29.60	(28.00-100.00)
New Hampshire	a		
Rhode Island	a		
Vermont	a		
All Region I	61.14 (7)	±46.12	(28.00-150.00)
Region II:			
New Jersey	41.00 (8)	±16.37	(18.00- 75.00)
New York	55.00 (5)	±38.57	(25.00- 120.00)
All Region II	46.38 (31)	±26.50	(18.00- 120.00)
Region III:			
Delaware	50.00 (1)		
Dist. of Columbia	a		
Maryland	40.00 (2)	±14.14	(30.00-50.00)
Pennsylvania	39.50 (4)	± 8.22	(30.00-50.00)
Virginia	37.50 (2)	±17.68	(25.00-50.00)
West Virginia	a		
All Region III	39.12 (8)	±10.16	(25.00-50.00)
Region IV:			
Alabama	a		
Florida	43.00 (5)	±32.52	(20.00-100.00)
Georgia	40.00 (1)		
Kentucky	a		
Mississippi	a		
North Carolina	42.50^b(4)	±39.69	(10.00-100.00)
South Carolina	c		
Tennesse	40.00 (1)		
All Region IV	42.27 (11)	±29.95	(10.00-100.00)
Region V:			
Illinois	57.50 (4)	±25.33	(25.00-80.00)
Indiana	50.00 (1)		
Michigan	33.33 (3)	±15.27	(20.00-50.00)
Minnesota	25.00 (2)	0	(25.00-25.00)
Ohio	96.43 (7)	±100.36	(20.00-300.00)
Wisconsin	27.50 (2)	± 3.53	(25.00-30.00)
All Region V	61.05 (19)	±66.22	(20.00-300.00
Region VI:			
Arkansas	a		
Louisiana	66.67 (3)	±38.19	(25.00-100.00)
New Mexico	a		
Oklahoma	a		
Texas	74.12 (8)	±32.61	(18.00-100.00)
All Region VI	72.09 (11)	±32.37	(18.00-100.00)
Region VII:			
Iowa	a		
Kansas	a		
Missouri	50.00 (1)		
Nebraska	250.00 (1)		
All Region VII	150.00 (2)	±141.42	(50.00-250.00)

TABLE 2

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	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado	$ 46.25 (4)	±14.93	(25.00-60.00)
Montana	a		
North Dakota	a		
South Dakota	a		
Utah	37.50 (2)	±17.68	(25.00-50.00)
Wyoming	a		
All Region VIII	43.33 (6)	±14.72	(25.00-60.00)
Region IX:			
Arizona	a		
California	32.00 (5)	± 4.47	(25.00-35.00)
Hawaii	17.50 (2)	±10.61	(10.00-25.00)
Nevada	100.00 (1)		
All Region IX	33.12 (8)	±29.15	(10.00-100.00)
Region X:			
Alaska	a		
Idaho	a		
Oregon	a		
Washington	43.00 (1)		
All Region X	43.00 (1)		
All Nation	54.14 (87)	±45.36	(10.00-300.00)

a. No information was obtained from this state.

b. Services provided upon request and without charge to employers within the State by the Consultative Services Section of the State Department of Labor.

c. Department of Health and Environmental Control have agreed to perform a minimum of bulk sample analysis for public schools.

TABLE 3

COSTS PER SAMPLE OF TESTING FRIABLE
MATERIALS FOR ASBESTOS BY X-RAY DIFFRACTION

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	$ 175.00 (2)	±106.07	(100.00-250.00)
Maine	a		
Massachusetts	96.67 (3)	± 50.33	(50.00-150.00)
New Hampshire	125.00 (1)		
Rhode Island	a		
Vermont	a		
All Region I	127.50 (6)	± 68.83	(50.00-250.00)
Region II:			
New Jersey	80.00 (7)	± 34.76	(50.00-150.00)
New York	71.67 (3)	± 45.68	(35.00-120.00)
All Region II	77.50 (10)	± 35.30	(35.00-150.00)
Region III:			
Delaware	a		
Dist. of Columbia	a		
Maryland	52.50 (2)	± 3.53	(50.00- 55.00)
Pennsylvania	76.67 (3)	± 20.82	(60.00-100.00)
Virginia	75.00 (1)		
West Virginia	a		
All Region III	68.33 (6)	± 18.07	(50.00-100.00)
Region IV:			
Alabama	a		
Florida	60.00 (1)		
Georgia	a		
Kentucky	25.00 (1)		
Mississippi	a		
North Carolina	95.00 (2)	± 7.07	(90.00-100.00)
South Carolina	a		
Tennesse	a		
All Region IV	68.75 (4)	± 33.76	(25.00-100.00)
Region V:			
Illinois	63.33 (3)	± 20.21	(40.00- 75.00)
Indiana	100.00 (1)		
Michigan	45.00 (5)	± 7.07	(35.00- 50.00)
Minnesota	35.00 (2)	0	(35.00- 35.00)
Ohio	42.50 (2)	± 10.61	(35.00- 50.00)
Wisconsin	a		
All Region V	51.54 (13)	± 20.04	(35.00- 75.00)
Region VI:			
Arkansas	a		
Louisiana	95.00 (3)	± 91.24	(35.00-200.00)
New Mexico	a		
Oklahoma	a		
Texas	84.44 (9)	± 25.43	(35.00-100.00)
All Region VI	87.08 (12)	± 44.79	(35.00-200.00)
Region VII:			
Iowa	a		
Kansas	100.00 (1)		
Missouri	200.00 (1)		
Nebraska	a		
All Region VII	150.00 (2)	± 70.71	(100.00-200.00)

TABLE 3

Page 2

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado	$ 83.33 (3)	± 57.73	(50.00-150.00)
Montana	a		
North Dakota	a		
South Dakota	a		
Utah	57.50 (2)	± 24.75	(40.00- 75.00)
Wyoming	a		
All Region VIII	73.00 (5)	± 44.94	(40.00-150.00)
Region IX:			
Arizona	a		
California	55.00 (3)	± 8.65	(50.00- 65.00)
Hawaii	60.00 (1)		
Nevada	100.00 (1)		
All Region IX	65.00 (5)	± 20.61	(50.00-100.00)
Region X:			
Alaska	a		
Idaho	a		
Oregon	a		
Washington	65.00 (1)		
All Region X	65.00 (1)		
All Nation	78.05 (64)	± 43.43	(25.00-250.00)

a. No information was obtained from this state.

TABLE 4

COSTS PER SAMPLE OF TESTING FRIABLE MATERIALS FOR ASBESTOS BY ELECTRON MICROSCOPY

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	$ 300.00 (1)		
Maine	a		
Massachusetts	190.00 (2)	±155.56	(80.00-300.00)
New Hampshire	92.50 (1)		
Rhode Island	a		
Vermont	a		
All Region I	193.12 (4)	±123.51	(80.00-300.00)
Region II:			
New Jersey	300.00 (1)		
New York	b		
All Region II	300.00 (1)		
Region III:			
Delaware	a		
Dist. of Columbia	a		
Maryland	200.00 (2)	± 70.71	(150.00-250.00)
Pennsylvania	a		
Virginia	162.50 (2)	± 53.03	(125.00-200.00)
West Virginia	a		
All Region III	181.25 (4)	± 55.43	(125.00-250.00)
Region IV:			
Alabama	a		
Florida	a		
Georgia	a		
Kentucky	a		
Mississippi	a		
North Carolina	140.00 (2)	± 56.57	(100.00-180.00)
South Carolina	a		
Tennesse	a		
All Region IV	140.00 (2)	± 56.57	(100.00-180.00)
Region V:			
Illinois	325.00 (2)	± 35.35	(300.00-350.00)
Indiana	150.00 (1)		
Michigan	150.00 (1)		
Minnesota	c		
Ohio	a		
Wisconsin	a		
All Region V	237.50 (4)	±103.08	(150.00-350.00)
Region VI:			
Arkansas	a		
Louisiana	a		
New Mexico	a		
Oklahoma	a		
Texas	108.33 (6)	± 20.41	(100.00-150.00)
All Region VI	108.33 (6)	± 20.41	(100.00-150.00)
Region VII:			
Iowa	a		
Kansas	100.00 (1)		
Missouri	200.00 (1)		
Nebraska	a		
All Region VII	150.00 (2)	± 70.71	(100.00-150.00)

TABLE 4

Page 2

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado	$ 75.00 (1)		
Montana	a		
North Dakota	a		
South Dakota	a		
Utah	100.00 (1)		
Wyoming	a		
All Region VIII	87.50 (2)	± 17.68	(75.00-100.00)
Region IX:			
Arizona	a		
California	300.00 (1)		
Hawaii	200.00 (1)		
Nevada	100.00 (1)		
All Region IX	200.00 (3)	±100.00	(100.00-300.00)
Region X:			
Alaska	a		
Idaho	a		
Oregon	a		
Washington	a		
All Region X	a		
All Nation	169.73 (28)	± 85.41	(75.00-350.00)

a. No information was obtained from this state.

b. $60.00 per hour is charged by one contractor.

c. Analysis is available, but no cost was provided by contractors.

TABLE 5

HOURLY COSTS OF MONITORING AIR IN SCHOOL BUILDINGS FOR AIRBORNE ASBESTOS

	Mean^{b} (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	$ 38.08 (3)	±12.93	(30.00- 53.00)
Maine	20.00 (1)		
Massachusetts	45.39 (6)	±10.11	(36.07- 62.50)
New Hampshire	a		
Rhode Island	a		
Vermont	a		
All Region I	40.66 (10)	±12.59	(30.00- 62.50)
Region II:			
New Jersey	43.21 (7)	±12.14	(25.00- 62.50)
New York	34.69 (4)	± 8.56	(25.00- 45.00)
All Region II	40.11 (11)	±11.35	(25.00- 62.50)
Region III:			
Delaware	35.00 (1)		
Dist. of Columbia	a		
Maryland	33.12 (2)	± 2.65	(31.25- 35.00)
Pennsylvania	33.53 (7)	±13.65	(23.50- 62.50)
Virginia	26.56 (2)	± 6.63	(21.87- 31.25)
West Virginia	a		
All Region III	32.34 (12)	±10.85	(21.87- 62.50)
Region IV:			
Alabama	a		
Florida	25.00 (2)	± 0	(25.00- 25.00)
Georgia	a		
Kentucky	a		
Mississippi	a		
North Carolina	30.00^{c} (1)		
South Carolina	a		
Tennesse	35.00 (1)		
All Region IV	28.75 (4)	± 4.79	(25.00- 35.00)
Region V:			
Illinois	43.65 (5)	±22.23	(27.50- 80.00)
Indiana	25.00 (1)		
Michigan	35.13 (4)	±11.47	(18.75- 45.00)
Minnesota	54.37 (2)	±15.03	(43.75- 65.00)
Ohio	33.44 (4)	± 7.73	(25.00- 43.75)
Wisconsin	32.50 (2)	± 3.53	(30.00- 35.00)
All Region V	38.44 (18)	±14.99	(18.75- 80.00)
Region VI:			
Arkansas	a		
Louisiana	a		
New Mexico	a		
Oklahoma	a		
Texas	34.10 (5)	±10.50	(25.00- 47.50)
All Region VI	34.10 (5)	±10.50	(25.00- 47.50)
Region VII:			
Iowa	a		
Kansas	25.00 (1)		
Missouri	78.12 (1)		
Nebraska	30.00 (1)		
All Region VII	44.37 (3)	±29.33	(25.00- 78.12)

TABLE 5

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado	30.62 (4)	± 5.15	(25.00- 37.50)
Montana	a		
North Dakota	a		
South Dakota	a		
Utah	a		
Wyoming	7.87 (1)		
All Region VIII	26.07 (5)	±11.11	(7.87- 37.50)
Region IX:			
Arizona	a		
California	40.60 (5)	± 5.64	(35.00- 50.00)
Hawaii	43.75 (2)	± 8.64	(37.50- 50.00)
Nevada	a		
All Region IX	41.50 (7)	± 6.05	(35.00- 50.00)
Region X:			
Alaska	a		
Idaho	a		
Oregon	a		
Washington	33.75 (2)	± 5.30	(30.00- 37.50)
All Region X	33.75 (2)	± 5.30	(30.00- 37.50)
All Nation	36.83 (77)	±12.84	(7.87- 80.00)

a. No information was obtained from this state.

b. This is an hourly rate for actual labor involved in in-school air monitoring. This cost does not include travel expenses, per diem, equipment costs, reproduction, report writing, telephone calls, etc.

c. "Services provided upon request and without charge to employers within the State by the Consultative Services Section of the State Department of Labor."

TABLE 6

COST PER SAMPLE OF ANALYSES OF ASBESTOS AIR SAMPLE BY OPTICAL MICROSCOPY (NIOSH METHOD)

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	$ 85.00 (4)	±110.30	(20.00-250.00)
Maine	a		
Massachusetts	48.40 (5)	± 31.31	(22.00-100.00)
New Hampshire	a		
Rhode Island	a		
Vermont	a		
All Region I	64.67 (9)	± 73.65	(20.00-250.00)
Region II:			
New Jersey	41.43 (7)	± 8.52	(30.00- 50.00)
New York	81.25 (4)	± 68.96	(25.00-180.00)
All Region II	55.91 (11)	± 43.29	(25.00-180.00)
Region III:			
Delaware	50.00(1)		
Dist. of Columbia	a		
Maryland	42.50 (2)	± 10.61	(35.00- 50.00)
Pennsylvania	31.43 (7)	± 11.80	(15.00- 50.00)
Virginia	37.50 (2)	± 17.68	(25.00- 50.00)
West Virginia	a		
All Region III	35.83 (12)	± 12.40	(15.00- 50.00)
Region IV:			
Alabama	a		
Florida	31.75 (4)	±14.22	(17.00- 50.00)
Georgia	40.00 (1)		
Kentucky	a		
Mississippi	a		
North Carolina	56.33[b] (3)	±39.51	(25.00-100.00)
South Carolina	a		
Tennesse	40.00 (1)		
All Region IV	41.89 (9)	±24.23	(17.00-100.00)
Region V:			
Illinois	32.00 (5)	± 16.81	(20.00- 60.00)
Indiana	50.00 (1)		
Michigan	17.90 (5)	± 3.47	(12.00- 20.00)
Minnesota	35.00 (2)	± 14.14	(25.00- 45.00)
Ohio	40.17 (6)	± 9.39	(25.00- 50.00)
Wisconsin	26.25 (4)	± 6.29	(20.00- 35.00)
All Region V	31.11 (23)	± 13.12	(12.00- 60.00)
Region VI:			
Arkansas	a		
Louisiana	147.33 (3)	±135.36	(42.00-300.00)
New Mexico	a		
Oklahoma	a		
Texas	72.87 (8)	± 33.19	(18.00-100.00)
All Region VI	93.18 (11)	± 75.13	(18.00-300.00)
Region VII:			
Iowa	25.00 (1)		
Kansas	100.00 (1)		
Missouri	50.00 (1)		
Nebraska	90.00 (1)		
All Region VII	66.25 (4)	± 34.97	(25.00-100.00)

TABLE 6

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado	$ 45.83 (6)	± 20.59	(20.00- 80.00)
Montana	a		
North Dakota	a		
South Dakota	a		
Utah	37.50 (2)	± 17.68	(25.00- 50.00)
Wyoming	15.00 (1)		
All Region VIII	40.55 (9)	± 20.22	(20.00- 80.00)
Region IX:			
Arizona	a		
California	30.33 (6)	± 10.13	(22.00- 50.00)
Hawaii	25.00 (2)	± 0	(25.00- 25.00)
Nevada	100.00 (1)		
All Region IX	36.89 (9)	± 25.09	(22.00-100.00)
Region X:			
Alaska	a		
Idaho	a		
Oregon	a		
Washington	22.00 (1)		
All Region X	22.00 (1)		
All Nation	48.25 (98)	± 42.92	(12.00-300.00)

a. No information was obtained from this state.

b. "Services provided upon request and without charge to employers within the State by the Consultative Services Section of the State Department of Labor."

TABLE 7

COSTS PER SAMPLE OF ANALYSES OF ASBESTOS AIR SAMPLES BY ELECTRON MICROSCOPY

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	283.33 (2)	± 23.57	(266.67[c]-300.00)
Maine	a		
Massachusetts	190.00 (2)	±155.56	(80.00-300.00)
New Hampshire	325.00 (1)		
Rhode Island	a		
Vermont	a		
All Region I	254.13 (5)	±100.26	(80.00-300.00)
Region II:			
New Jersey	283.33 (2)	± 23.57	(266.67[c]-300.00)
New York	b		
All Region II	283.33 (2)	± 23.57	(266.67[c]-300.00)
Region III:			
Delaware	a		
Dist. of Columbia	a		
Maryland	272.50[d] (1)		
Pennsylvania	308.33 (2)	± 58.92	(266.67[c]-350.00)
Virginia	200.00 (1)		
West Virginia	a		
All Region III	272.29 (4)	± 61.36	(200.00-350.00)
Region IV:			
Alabama	a		
Florida	a		
Georgia	a		
Kentucky	a		
Mississippi	a		
North Carolina	100.00 (1)		
South Carolina	a		
Tennesse	a		
All Region IV	100.00 (1)		
Region V:			
Illinois	325.00 (2)	±35.35	(300.00-350.00)
Indiana	100.00 (1)		
Michigan	150.00 (1)		
Minnesota	a		
Ohio	a		
Wisconsin	100.00 (1)		
All Region V	200.00 (5)	±117.26	(100.00-350.00)
Region VI:			
Arkansas	a		
Louisiana	250.00 (2)	±212.13	(100.00-400.00)
New Mexico	a		
Oklahoma	a		
Texas	108.33 (6)	± 20.41	(100.00-150.00)
All Region VI	143.75 (8)	±105.01	(100.00-400.00)
Region VII:			
Iowa	a		
Kansas	100.00 (1)		
Missouri	50.00 (1)		
Nebraska	a		
All Region VII	75.00 (2)	± 35.35	(50.00-100.00)

TABLE 7

Page 2

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado	$ 75.00 (1)		
Montana	a		
North Dakota	a		
South Dakota	a		
Utah	100.00 (1)		
Wyoming	a		
All Region VIII	87.50 (2)	± 17.68	(75.00-100.00)
Region IX:			
Arizona	a		
California	270.00 (1)		
Hawaii	a		
Nevada	100.00 (1)		
All Region IX	185.00 (2)	±120.21	(100.00-270.00)
Region X:			
Alaska	a		
Idaho	a		
Oregon	a		
Washington	a		
All Region X	a		
All Nation	189.43 (31)	±106.17	(50.00-400.00)

a. No information was obtained from this state.

b. $60.00 per hour.

c. $100.00/sample for scanning EM; $300.00/sample for SEM + EDS; $400.00/sample for transmission EM; (100.00 + 300.00 + 400.00) = 266.67/sample.

d. $320.00/sample for Transmission EM; $225.00/sample for Scanning EM; ($320.00 + 225.00) = $272.50/sample.

TABLE 8

COST PER SQUARE FOOT OF REMOVAL OF FRIABLE ASBESTOS * ACCORDING TO APPLICABLE GOVERNMENT REGULATIONS

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	$ 3.00 (2)	±1.41	(2.00-4.00)
Maine	4.00 (1)		
Massachusetts	4.50 (2)	±1.06	(3.75-5.25)
New Hampshire	a		
Rhode Island	b		
Vermont	2.25 (1)		
All Region I	3.54 (6)	±1.22	(2.00-5.25)
Region II:			
New Jersey	5.00 (1)		
New York	3.80 (2)	±3.25	(1.50-6.10)
All Region II	4.20 (3)	±2.40	(1.50-6.10)
Region III:			
Delaware	a		
Dist. of Columbia	a		
Maryland	$130.00 per seven (7) cubic foot or 55-gallon drum		
Pennsylvania	2.75 (2)	±2.47	(1.00-4.50)
Virginia	10.00 (1)		
West Virginia	a		
All Region III	5.17 (3)	±4.54	(1.00-10.00)
Region IV:			
Alabama	a		
Florida	8.25[c] (1)		
Georgia	3.00 (1)		
Kentucky	4.00[e] (1)		
Mississippi	a		
North Carolina	5.00[f] (2)	±0	(5.00-5.00)
South Carolina	a		
Tennesse	4.00 (1)		
All Region IV	4.87 (6)	±1.81	(3.00-8.25)
Region V:			
Illinois	b		
Indiana	3.27 (2)	±2.44	(1.55-5.00)
Michigan	a		
Minnesota	b		
Ohio	5.50 (1)		
Wisconsin	b		
All Region V	4.02 (3)	±2.15	(1.55-5.50)
Region VI:			
Arkansas	b		
Louisiana	5.12[f] (2)	±0.18	(5.00-5.25)
New Mexico	b		
Oklahoma	b		
Texas	4.85[f] (5)	±0.49	(4.00-5.25)
All Region VI	4.93 (7)	±0.43	(4.00-5.25)
Region VII:			
Iowa	a		
Kansas	5.25 (1)		
Missouri	13.75 (1)		
Nebraska	a		
All Region VII	9.50 (2)	±6.01	(5.25-13.75)

*These costs do not include an estimated 16 percent for materials such as respirators, protective overalls/masks, and other equipment necessary to complete removal.

TABLE 8 Page 2

	Mean (Sample Size)		± 1 Standard Deviation	Range
Region VIII:				
Colorado	$ a			
Montana	a			
North Dakota	a			
South Dakota	a			
Utah	b			
Wyoming	a			
All Region VIII	a or b			
Region IX:				
Arizona	a			
California	b			
Hawaii	d			
Nevada	10.50	(1)		
All Region IX	10.50	(1)		
Region X:				
Alaska	a			
Idaho	a			
Oregon	b			
Washington	3.50	(1)		
All Region X	3.50	(1)		
All Nation	4.94	(32)	±2.62	(1.00-13.75)

a. No information was obtained from this state.

b. Services are available, but no estimates of costs were provided by contractors

c. (2.50 + 14.00)/2 = 8.25 per square foot. $2.50 per square foot if a flat concrete ceiling is involved. $14.00 per square foot if bar joints and corrugated metal deckings are involved.

d. A contractor estimated that combined removal, disposal, encapsulation/enclosure, and marking would cost $29.52/ft^2. This does not include the cost of materials.

e. (6.00 + 2.00)/2 = $4.00 per square foot for ripping and replacement.

f. For partial removal of friable asbestos, an average price of $3.50/ft^2 was quoted.

TABLE 9

COSTS OF DISPOSAL OF FRIABLE ASBESTOS ACCORDING TO GOVERNMENT REGULATIONS, PER SQUARE FOOT OF SURFACE REMOVED

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	b		
Maine	b		
Massachusetts	b		
New Hampshire	a		
Rhode Island	b		
Vermont	b		
All Region I	b		
Region II:			
New Jersey	0.15[d] (1)		
New York	0.50 (1)		
All Region II	0.32 (2)	±0.25	(0.15-0.50)
Region III:			
Delaware	a		
Dist. of Columbia	a		
Maryland	1.55[e] (1)		
Pennsylvania	0.01[f] (1)		
Virginia	b		
West Virginia	a		
All Region III	0.78 (2)	±1.09	(0.01-1.55)
Region IV:			
Alabama	a		
Florida	b		
Georgia	0.40 (1)		
Kentucky	0.07[d] (1)		
Mississippi	a		
North Carolina	0.075 (1)		
South Carolina	a		
Tennesse	a		
All Region IV	0.18 (3)	±0.19	(0.07-0.40)
Region V:			
Illinois	b		
Indiana	1.37 (1)		
Michigan	a		
Minnesota	a		
Ohio	0.04[d] (1)		
Wisconsin	b		
All Region V	0.70 (2)	±0.94	(0.04-1.37)
Region VI:			
Arkansas	b		
Louisiana	0.16 (2)	±0.12	(0.075-0.25)
New Mexico	b		
Oklahoma	b		
Texas	0.08 (4)	±0.01	(0.075-0.10)
All Region VI	0.11 (6)	±0.07	(0.05-0.25)
Region VII:			
Iowa	a		
Kansas	0.075 (1)		
Missouri	0.34[d,g] (1)		
Nebraska	a		
All Region VII	0.21 (2)	±0.19	(0.075-0.34)

TABLE 9

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	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado	a		
Montana	a		
North Dakota	a		
South Dakota	a		
Utah	b		
Wyoming	a		
All Region VIII	b		
Region IX:			
Arizona	a		
California	0.96[d] (1)		
Hawaii	c		
Nevada	a		
All Region IX	0.96 (1)		
Region X:			
Alaska	a		
Idaho	a		
Oregon	a		
Washington	0.15[d] (1)		
All Region X	0.15 (1)		
All Nation	0.33 (19)	±0.46	(0.01-1.55)

a. No information was obtained from this state.

b. Services are available, but no estimation of costs was provided by contractors.

c. A contractor estimated that combined removal, disposal, encapsulation/enclosure, and marking would cost $29.52/ft^2. This does not include the cost of materials.

d. Assume that one (1)-inch thickness of friable material is removed.

e. Includes marking of waste.

f. Plus $120-150 for handling charge run, and $60 per month for container rental.

g. Plus transportation.

TABLE 10

COSTS PER SQUARE FOOT OF ENCAPSULATION OF ASBESTOS CONTAINING MATERIALS

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	$ 2.75 (2)	±0.35	(2.50-3.00[c])
Maine	1.10 (1)		
Massachusetts	1.20 (1)		
New Hampshire	a		
Rhode Island	b		
Vermont	b		
All Region I	1.95 (4)	±0.95	(1.10-3.00)
Region II:			
New Jersey	1.25 (1)		
New York	4.30 (2)	±0.28	(4.10-4.50)
All Region II	3.28 (3)	±1.77	(1.25-4.50)
Region III:			
Delaware	a		
Dist. of Columbia	a		
Maryland	3.14 (1)		
Pennsylvania	1.81 (2)	±0.08	(1.75-1.87)
Virginia	4.00 (1)		
West Virginia	a		
All Region III	2.98 (4)	±1.10	(1.75-4.00)
Region IV:			
Alabama	a		
Florida	b		
Georgia	2.00 (1)		
Kentucky	2.06[d] (1)		
Mississippi	a		
North Carolina	2.12 (2)	±0.18	(2.00-2.25)
South Carolina	a		
Tennesse	1.50 (1)		
All Region IV	1.96 (5)	±0.28	(1.50-2.25)
Region V:			
Illinois	b		
Indiana	2.88 (2)	±1.22	(2.02[f]-3.75)
Michigan	0.72 (2)	±0.04	(0.69-0.75)
Minnesota	b		
Ohio	1.22 (2)	±0.67	(0.75[e]-1.70)
Wisconsin	b		
All Region V	1.61 (6)	±1.19	(0.69-3.75)
Region VI:			
Arkansas	0.40 (1)		
Louisiana	2.25 (2)	±0.35	(2.00-2.50)
New Mexico	b		
Oklahoma	b		
Texas	2.15 (5)	±0.22	(2.00[g]-2.50)
All Region VI	1.96 (8)	±0.67	(0.40-2.50)
Region VII:			
Iowa	a		
Kansas	2.00 (1)		
Missouri	3.75 (1)		
Nebraska	a		
All Region VII	2.87 (2)	±1.24	(2.00-3.75)

TABLE 10

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado	$ a		
Montana	b		
North Dakota	a		
South Dakota	a		
Utah	b		
Wyoming	a		
All Region VIII	a or b		
Region IX:			
Arizona	3.50 (1)		
California	b		
Hawaii	b		
Nevada	4.25 (1)		
All Region IX	3.87 (2)	±0.53	(3.50-4.25)
Region X:			
Alaska	a		
Idaho	b,d		
Oregon	a		
Washington	1.80 (3)	±0.77	(1.13-2.65)
All Region X	1.80 (3)	±0.77	(1.13-2.65)
All Nation	2.23 (37)	±1.06	(0.40-4.50)

a. No information was obtained from this state.

b. Services are available, but no estimation of costs was provided by contractors.

c. $3.00 per square foot includes the "Marking" service.

d. Encapsulated with K-13 sealant.

e. Encapsulated with latex paint.

f. $3.25 per foot for piping; $0.80 per square foot for walls and ceilings: (3.25 + 0.80)/2 = $2.02 per square foot.

g. $1.50 per square foot, if airborne fiber count is below the established standard: $2.50 per square foot if the count is above standard; (1.50 + 2.50) = $2.00 for square foot. Encapsulation with K-13.

TABLE II

COSTS PER SQUARE FOOT OF ENCLOSURE OF ASBESTOS CONTAINING MATERIALS

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	$ 3.75 (2)	±0.35	(3.50[c]-4.00)
Maine	b		
Massachusetts	1.86 (1)		
New Hampshire	a		
Rhode Island	b		
Vermont	b		
All Region I	3.12 (3)	±1.12	(1.86-4.00)
Region II:			
New Jersey	a		
New York	5.40[d] (1)		
All Region II	5.40 (1)		
Region III:			
Delaware	a		
Dist. of Columbia	a		
Maryland	a		
Pennsylvania	b		
Virginia	b		
West Virginia	a		
All Region III	a or b		
Region IV:			
Alabama	a		
Florida	b		
Georgia	0.36 (1)		
Kentucky	4.50 (1)		
Mississippi	a		
North Carolina	5.00 (1)		
South Carolina	a		
Tennesse	a		
All Region IV	3.29 (3)	±2.55	(0.36-5.00)
Region V:			
Illinois	b		
Indiana	4.25 (1)		
Michigan	0.69 (1)		
Minnesota	a		
Ohio	5.25 (1)		
Wisconsin	b		
All Region V	3.40 (3)	±2.40	(0.69-4.25)
Region VI:			
Arkansas	b		
Louisiana	4.75 (2)	±0.35	(4.50-5.00[e])
New Mexico	a		
Oklahoma	b		
Texas	3.91 (5)	±1.07	(2.55[f]-5.00)
All Region VI	4.15 (7)	±0.97	(2.55-5.00)
Region VII:			
Iowa	a		
Kansas	5.00 (1)		
Missouri	6.25 (1)		
Nebraska	a		
All Region VII	5.62 (2)	±0.88	(5.00-6.25)

TABLE 11

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado	$ a		
Montana	b		
North Dakota	a		
South Dakota	a		
Utah	b		
Wyoming	a		
All Region VIII	a or b		
Region IX:			
Arizona	a		
California	b		
Hawaii	b		
Nevada	6.00 (1)		
All Region IX	6.00 (1)		
Region X:			
Alaska	a		
Idaho	a		
Oregon	a		
Washington	a		
All Region X	a		
All Nation	4.05 (20)	±1.62	(0.36-6.25)

a. No information was obtained from this state.

b. Services are available, but no estimation of costs was provided by contractors.

c. $3.50 per square foot includes "Marking" services.

d. New York City only.

e. "Slash barriers by installing metal bathe system and applying 3/4 inch thickness K-13 insulation at the rate of $5.00 per square foot."

f. "Any ceiling repair will be charged at removal rate ($4.00 per square foot). The cost to apply sound, temperature, and fire control material at 1 inch thickness is additional $1.90 per square foot."

TABLE 12

COSTS OF MARKING PER SQUARE FOOT OF AREA REQUIRING TO BE MARKED

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	b		
Maine	b		
Massachusetts	a		
New Hampshire	a		
Rhode Island	b		
Vermont	b		
All Region I			
Region II:			
New Jersey	a		
New York	b		
All Region II			
Region III:			
Delaware	a		
Dist. of Columbia	a		
Maryland	b		
Pennsylvania	b		
Virginia	b		
West Virginia	a		
All Region III			
Region IV:			
Alabama	a		
Florida	b		
Georgia	0.30 (1)		
Kentucky	a		
Mississippi	a		
North Carolina	0.03 (1)		
South Carolina	a		
Tennesse	a		
All Region IV	0.16 (2)	±0.19	(0.03-0.30)
Region V:			
Illinois	a		
Indiana	$25.00 per hour is estimated.		
Michigan	$45.00 per hour is estimated.		
Minnesota	a		
Ohio	$15.00 for metal, urethane coated signs, plus travel.		
Wisconsin	b		
All Region V			
Region VI:			
Arkansas	b		
Louisiana	0.04 (2)	±0.01	(0.03-0.05)
New Mexico	a		
Oklahoma	a		
Texas	0.03 (4)	±0.02	(0.01-0.05)
All Region VI	0.03 (6)	±0.02	(0.01-0.05)
Region VII:			
Iowa	a		
Kansas	0.03 (1)		
Missouri	$500.00 to $2,000.00 per facility for marking plus air monitoring if closed down.		
Nebraska	a		
All Region VII	0.03 (1)		

TABLE 12

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	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado	a		
Montana	a		
North Dakota	a		
South Dakota	a		
Utah	b		
Wyoming	b		
All Region VIII			
Region IX:			
Arizona	a		
California	c		
Hawaii	b		
Nevada	a		
All Region IX			
Region X:			
Alaska	a		
Idaho	a		
Oregon	a		
Washington	a		
All Region X			
All Nation	0.06 (9)	±0.09	(0.01-0.30)

a. No information was obtained from this state.

b. Services are available, but no costs were provided by contractors.

c. The contractor provides the labels for "Marking." The cost of labels vary from $4.40/25 labels to $6.25/25 labels depending on the type of labels.

TABLE 13

COSTS PER SQUARE FOOT FOR INSULATION REPLACEMENT AFTER ASBESTOS REMOVAL

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	$0.92 (2)	±0.11	(0.85-1.00)
Maine	0.40 (1)		
Massachusetts	0.40 (1)		
New Hampshire	a		
Rhode Island	b		
Vermont	b		
All Region I	0.66 (4)	±0.31	(0.40-1.00)
Region II:			
New Jersey	0.45 (1)		
New York	1.45 (2)	±0.07	(1.40-1.50)
All Region II	1.62 (3)	±1.29	(0.45-1.50)
Region III:			
Delaware	a		
Dist. of Columbia	a		
Maryland	1.05 (1)		
Pennsylvania	0.62 (2)	±0.03	(0.60-0.65)
Virginia	1.35 (1)		
West Virginia	a		
All Region III	0.91 (4)	±0.35	(0.60-1.35)
Region IV:			
Alabama	a		
Florida	b		
Georgia	0.70 (1)		
Kentucky	0.70 (1)		
Mississippi	a		
North Carolina	0.72 (2)	±0.03	(0.70-0.75)
South Carolina	a		
Tennesse	0.50 (1)		
All Region IV	0.66 (5)	±0.09	(0.50-0.75)
Region V:			
Illinois	b		
Indiana	0.97 (2)	±0.39	(0.70-1.25)
Michigan	0.35 (2)	0	(0.35-0.35)
Minnesota	b		
Ohio	0.47 (2)	±0.18	(0.35-0.60)
Wisconsin	b		
All Region V	0.60 (6)	±0.35	(0.35-1.25)
Region VI:			
Arkansas	0.35 (1)		
Louisiana	0.77 (2)	±0.11	(0.70-0.85)
New Mexico	b		
Oklahoma	b		
Texas	0.73 (5)	±0.07	(0.70-0.85)
All Region VI	0.69 (8)	±0.15	(0.35-0.85)
Region VII:			
Iowa	a		
Kansas	0.70 (1)		
Missouri	1.25 (1)		
Nebraska	a		
All Region VII	0.97 (2)	±0.39	(0.70-1.25)

TABLE 13

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado	a		
Montana	b		
North Dakota	a		
South Dakota	a		
Utah	b		
Wyoming	a		
All Region VIII			
Region IX:			
Arizona	1.20 (1)		
California	b		
Hawaii	b		
Nevada	1.45 (1)		
All Region IX	1.32 (2)	±0.18	(1.20-1.45)
Region X:			
Alaska	a		
Idaho	b		
Oregon	a		
Washington	0.60 (1)		
All Region X	0.60 (1)		
All Nation	0.78 (35)	±0.33	(0.35-1.50)

a. No information was obtained from this state.

b. Services are available, but no estimation of costs was provided by contractors.

TABLE 14

REGIONAL AVAILABILITY OF SERVICES RELATING TO CONTROL OF ASBESTOS EXPOSURES IN SCHOOLS

Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing			Air Monitoring	Air Sample Quantification		Removal	Disposal	Encapsulation	Enclosure	Marking
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy		Optical Microscopy (NIOSH) Method	Electron Microscopy					
Region I:											
ACMAT Corporation 141 Prestige Park Road E. Hartford, CT 06108 (203) 289-6493	X	X	X	X	X	X	X	X	X	X	X
AEtna Technical Services, Inc. 151 Farmington Avenue Hartford, CT 06156 (203) 273-4631				X	X						
H.E. Murdock & Sons, Inc. P.O. Box 45 West Haven, CT 06516 (203) 933-0572							X		X	X	
Springborn Laboratories, Inc. 9 Water Street Enfield, CT 06082 (203) 749-8371				X			X				
Structure Probe, Inc. 1100 Main Street Suite 306 Bridgeport, CT 06604 (203) 333-5400	X	X		X	X	X					
York Research Corp. One Research Drive Stamford, CT 06906 (203) 325-1371				X	X						
Page Hill Corporation Main Road, Box 50 Winterport, ME 04496 (207) 223-4655				X			X	X	X	X	X
Anderson-Nichols & Co., Inc. Environmental Analysis Laboratory 150 Causeway Street Boston, MA 02114 (617) 742-3400	X	X	X	X	X	X	X	X	X	X	X
American Mutual Insurance Company American Mutual Labs. Wakefield, MA 01880 (617) 245-6000, Ext. 339	X			X	X						
Arthur D. Little, Inc. Acorn Park Cambridge, MA 02140 (617) 864-5770	X	X	X	X	X	X					
Eastern Analytical Lab., Inc. One "A" Street Burlington, MA 01803 (617) 272-5212	X		X	X	X						

TABLE 14

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Region No.:	Bulk Testing				Air Sample Quantification						
Name & Address of Laboratories or Contractors Telephone Number	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy	Air Monitoring	Optical Microscopy (NIOSH) Method	Electron Microscopy	Removal	Disposal	Encapsulation	Enclosure	Marking
Region I:											
GCA Corporation Technology Divisions Burlington Road Bedford, MA 01730 (617) 275-9000	X	X	X	X	X	X					
J.H. Clausen, Ph.D. P.O. Box 400 Lexington, MA 02173 (617) 862-9391				X							
Recycling Industries, Inc. 385 Quincy Avenue Braintree, MA 02184 (617) 848-0612								X			
Skinner S. Sherman Laboratories, Inc. 300 Second Avenue Waltham, MA 02254 (617) 890-7200	X	X	X	X	X	X					
Symmes, Maini & McKee, Inc. 1050 Massachusetts Ave. Cambridge, MA 02138 (617) 547-5400				X							
U.S. Coatings Collaborative, Inc. 201 Marginal Street Chelsea, MA 02150 (617) 884-6644	X				X				X		
Center for Industrial & Institutional Development Univ. of New Hampshire Durham, MA 03824 (603) 862-1354		X	X			X					
Concents, Ltd. P.O. Box 777 Woonsocket, RI 02895 (401) 766-7706							X				
Coastal Services, Inc. Adminis. Bldg. #7 Davisville, RI 02854 (401) 433-3100							X	X	X	X	X
Engelberth Construction, Inc. 1700 Hegeman Avenue Winooski, VT 05404 (802) 665-0611							X	X	X	X	X
Region II:											
American Can Company Safety & Indus. Hygiene Laboratory U.S. Highway 22 Union, NJ 07083 (201) 686-4500	X			X	X						

TABLE 14

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Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing			Air Monitoring	Air Sample Quantification		Removal	Disposal	Encapsulation	Enclosure	Marking
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy		Optical Microscopy (NIOSH) Method	Electron Microscopy					
Region II:											
American Hazard Control Consultants, Inc. P.O. Drawer 188 Essex Fells, NJ 07021 (201) 226-4835				X							
Duall, Inc. RD 1 Union Mill Road Mt. Laurel, NJ 08054 (609) 235-1073									X	X	
Dyer Insulations 70 Cobb Street Rockaway, NJ 07866 (201) 627-8020									X		
Ecology International 400 N. Bridge Street Bridgewater, NJ 08807 (201) 526-2802	X	X		X	X						
Environmental Consulting & Testing Services P.O. Box 3521 Cherry Hill, NJ 08034 (609) 779-1195	X	X		X	X						
KRC Research Corporation 315 N. Washington Avenue Moorestown, NJ 08057 (609) 234-3061	X	X					X		X		
Newco Chemical Waste Systems, Inc. 2001-C Greentree Executive Campus Rt. 73 Marlton, NJ 08053 (609) 983-6662								X			
Princeton Testing Lab. P.O. Box 3108 Princeton, NJ 08540 (609) 452-9050				X							
Recon Systems, Inc. 51 Fifth Street P.O. Box 842 Somerville, NJ 08876 ATTN: R.F. Toro	X	X	X	X	X	X					
Rossnagel & Associates 234 Rt. 70 Medford, NJ 08055 (609) 654-1441	X	X	X	X	X	X					
Structure Probe, Inc. 230 E. Forrest Street Metuchen, NJ 08840 (201) 549-9350	X	X		X	X	X					

TABLE 14

Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing			Air Monitoring	Air Sample Quantification		Removal	Disposal	Encapsulation	Enclosure	Marking
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy		Optical Microscopy (NIOSH) Method	Electron Microscopy					
Region II:											
United States Testing Company, Inc. Environmental Science Division 1415 Park Avenue Hoboken, NJ 07030 (201) 792-2400 or (212) 943-0488	X	X		X	X						
Cellu-Spray Corporation 307 E. Main Street Malone, NY 12953 (518) 483-2145							X	X	X		
Townley Research and Consulting, Inc. 591 Somerset Street N. Plainfield, NJ 07060	X			X	X						
W.J. Kearney, Inc. 127 Crooks Avenue Paterson, NJ 07503 (201) 345-1436							X		X		
Martell Construction Company, Inc. 15 S. Miller Avenue Penns Grove, NJ 08069 (609) 299-1720							X		X		
T.J. McGlone Company 40 Brunswick Avenue Box 679 Edison, NJ 08817 (201) 287-8500							X		X		
Power-Vac Cleaning Div. of Olesen & Hassold E. 26th Street Paterson, NJ 07514 (201) 431-5441							X		X		
Guardian, Inc. 60 Jerseyville Avenue Freehold, NJ 07728 (201) 462-5771							X		X		
McGeddy International, Inc. 1043 Broadway W. Long Branch, NJ 07764 (201) 229-5580							X		X		
Chemical Pollution Control Volumetric Techniques 120 S. 4th Street BayShore, NY 11706								X	X	X	X
Fred C. Hart Assoc. Inc. 527 Madison Avenue New York, NY 10022 (212) 371-1140 ATTN: Toxics & Environmental Services Group							X	X			

TABLE 14

Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing			Air Monitoring	Air Sample Quantification		Removal	Disposal	Encapsulation	Enclosure	Marking
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy		Optical Microscopy (NIOSH) Method	Electron Microscopy					
Region II:											
Galson Technical Services, Inc. 6601 Kirkville Road E. Syracuse, NY 13057 (315) 437-7181	X			X	X						
Industrial Hygienics, Inc. 755 New York Avenue Huntington, NY 11743 (516) 427-0950	X	X			X		X	X	X		
Newing Laboratories, Inc. 260 Islip Avenue Islip, NY 11751 (516) 581-3729	X			X	X						
Riverside Engineers, Inc 310 Riverside Drive New York, NY 10025 ATTN: Jack Kroop, P.E.				X							
State Univ. of New York College at New Paltz Dept. of Geological Sciences New Paltz, NY 12562 ATTN: Martin S. Rutstein Chairman	X	X			X						
The Carborundum Company P.O. Box 1054 Niagara Falls, NY 14302 (716) 278-6347	X	X	X		X	X					
Universal Insulation Co., Inc. 2138 Lockport Road Niagara Falls, NY 14304 (716) 731-5511									X		
Region III:											
Crippen Laboratories 2313 W. 6th Street Wilmington, DE 19805 (302) 571-8882	X			X	X						
Chesapeake Insulation, Inc. 2125 Baldwin Avenue # 438 Crofton, MD 21114 (301) 261-6120 or (301) 721-2822							X		X		
EMV Associates, Inc. Microanalysis Laboratory 15825 Shady Grove Road Rockville, MD 20850 (301) 948-7400	X	X	X	X	X	X					
Martin Marietta Lab. 1450 S. Rolling Road Baltimore, MD 21227 (301) 247-0700		X	X	X							

TABLE 14

Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing				Air Sample Quantification						
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy	Air Monitoring	Optical Microscopy (NIOSH) Method	Electron Microscopy	Removal	Disposal	Encapsulation	Enclosure	Marking
Region III:											
Maryland Mineral Analysis Laboratory P.O. Box V College Park, MD 20740 (301) 949-0337	X				X						
RAD Services, Inc. Hazardous Waste Management Division 3527 Whiskey Bottom Rd. Laurel, MD 20810							X				X
The BA-MOR Co., Inc. 2810 Hampden Avenue Baltimore, MD 21211 (301) 467-9200									X		
Thermal Acoustics Foam Insulation, Inc. 6655 Dobbin Road Columbia, MD 21045 ATTN: Jack Lamon									X		
Acoustical Spray Insulators Box 625 Allentown, PA 18105 (215) 797-9272							X		X		
Betz, Converse, Murdock, Inc. One Plymouth Meeting Mall Plymouth Meeting, PA 19462 (215) 825-3800				X	X						
Dept. of Environmental Resources Bureau of Occupational Health 1204 Kossman Building 100 Forbes Avenue Pittsburgh, PA 15222 (412) 565-5012	X										
Environmental Testing Laboratory Division of Microbac Lab. 2401 W. 26th Street Erie, PA 16506 (914) 833-4790	X	X		X							
Erie Disposal Company 1154 West 16th Street Erie, PA 16512 (814) 459-4731								X			
Franklin Research Ctr. The Benjamin Franklin Parkway Philadelphia, PA 19103 (215) 448-1000				X	X	X					
Freeport Brick Company Free-Col Division P.O. Box 557, Cotton Rd. Meadville PA 16335 (814) 724-6242				X	X						

TABLE 14

Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing				Air Sample Quantification						
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy	Air Monitoring	Optical Microscopy (NIOSH) Method	Electron Microscopy	Removal	Disposal	Encapsulation	Enclosure	Marking
Region III:											
Gannett, Fleming, Corddry & Carpenters, Inc. P.O. Box 1963 Harrisburg, PA 17105 (717) 763-7211	X			X	X						
H.L. Clement Company Box 86 Sewickley, PA 15143 (412) 266-9280							X	X	X	X	
Jack Frost Construction, Inc. 300 Homan Avenue State College, PA 16801 (814) 237-6531							X	X	X		
Lancaster Laboratories, Inc. 2425 New Holland Pike Lancaster, PA 17601 (717) 656-2301				X	X						
Structure Probe, Inc. 535 E. Gay Street WestChester, PA 19380 (215) 436-5400	X	X		X	X	X					
Suntech Group P.O. Box 1135 Marcus Hook, PA 19061 (215) 447-1700	X	X			X						
Tri-State Insulation, Inc. 8164 Pagan Road Erie, PA 16509							X	X	X	X	X
Edwin Cox Associates Chemists Building 2209 East Broad Street Richmond, VA 23223 (804) 648-8358	X		X	X	X	X					
Interscience Research, Inc. 2614 Wyoming Avenue Norfolk, VA 23513 ATTN: Dr. Joseph H. Guth	X	X	X	X	X						
O.H. Materials, Inc. Crystal 3, Suite 203 1735 Jefferson Davis Hwy. Arlington, VA 22202 (703) 521-5575							X	X			
Pentagon Plastics, Ltd. 7659 C Fullerton Road Springfield, VA 22153 (703) 569-5277							X		X	X	
Region IV:											
Asbestos Removers, Inc. of Wayne Blackwell & Co., Inc. 7330 N.W. 8th Street Miami, FL 33126							X				

TABLE 14

Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing				Air Sample Quantification						
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy	Air Monitoring	Optical Microscopy (NIOSH) Method	Electron Microscopy	Removal	Disposal	Encapsulation	Enclosure	Marking
Region IV:											
Environmental Analyses & Design, Inc. 4720 N. Orange Blossom Trail Orlando, FL 32804 (305) 295-4131	X			X	X						
Environmental Science & Engineering, Inc. P.O. Box 13454 Gainsville, FL 32604 (904) 372-3318	X										
GeoScience Consultants P.O. Box 341366 Coral Gables, FL 33134 (305) 446-5801	X	X			X						
North Brothers, Co. 2221 Pearl Street Jacksonville, FL 32201 (904) 354-6701							X	X	X	X	X
Sealants & Waterproofing Specialists 1451 Southwest 11th Terrace Pompano Beach, FL 33060							X				
Technical Services, Inc. 103-7 Stockton Street P.O. Box 52329 Jacksonville, FL 32201 (904) 353-5761	X			X	X						
Thornton Laboratories, Inc. 1145 East Cass Street Tampa, FL 33601 (813) 223-9702	X			X	X						
Chemical Waste Management, Inc. 2131 Kingston Ct., S.E. Suite 112 Marietta, GA 30067 (1-800) 241-7829								X			
Environmental Health Laboratory 1021 Georgia Avenue Macon, GA 31201 (912) 745-4702	X				X						
North Brothers Company 3250 Woodstock Rd., S.E. Atlanta, GA 30301							X	X	X	X	X
Acoustical Spray Insulators, Inc. 206 S. Richardson Drive Somerset, KY 42501									X		
Becklin Insulation Co., Inc. 2338 Frankfort Avenue Louisville, KY 40206 (502) 897-3573							X	X	X	X	

TABLE 14

Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing			Air Monitoring	Air Sample Quantification		Removal	Disposal	Encapsulation	Enclosure	Marking
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy		Optical Microscopy (NIOSH) Method	Electron Microscopy					
Region IV:											
Seagull Environmental Company 2100 Camargo Road Louisville, Kentucky							X	X	X	X	
Watkins S. Assoc., Inc. 446 E. High Street Lexington, KY 40588 (606) 252-4951		X									
Environmental Testing, Inc. 5022 Park Road Charlotte, NC 28209 (704) 525-9379	X			X	X						
Law Engineering Testing Company P.O. Box 18288 3301 Winton Road Raleigh, NC 27609 (919) 876-0416	X	X	X	X							
Northrop Services, Inc. P.O. Box 12313 Research Triangle Park, NC 27709 (919) 549-0611	X			X	X						
Piedmont Energy Planners, Ing. P.O. Box 8922 Greensboro, NC 27410 (919) 299-3255							X	X	X		X
Rapco Foam Insulation Company 3002 Harvard Avenue Durham, NC 27703 (919) 596-2127							X	X	X	X	X
AWARE Inc./Labs. 2907 12th Avenue, S. Nashville, TN 37204 (615) 383-4581	X				X						
North Brothers Company 995 N. Hollywood Street Memphis, TN 38108 (901) 323-2611							X		X		
Resources Consultants, Inc. P.O. Box 498 Two Maryland Farms Suite 340 Brentwood, TN 37027 (615) 373-5040	X			X	X						

TABLE 14

Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing: Petroscopic Microscopy	Bulk Testing: X-Ray Diffraction	Bulk Testing: Electron Microscopy	Air Monitoring	Air Sample Quantification: Optical Microscopy (NIOSH) Method	Air Sample Quantification: Electron Microscopy	Removal	Disposal	Encapsulation	Enclosure	Marking
Region V:											
Air-O-Term Application Company, Inc. 225 North Arlington Heights Road Elk Grove Village, IL 60007 (312) 625-6781 or (312) 439-2646							X	X	X	X	
Erlin, Hime Associates 811 Skokie Blvd. Northbrook, IL 60062 (312) 272-7730	X	X									
Gabriel and Associate 1814 N. Marshfield Chicago, IL 60622 (312) 486-2123	X	X	X	X	X	X					
Globe Engineering Co. 222 N. Dearborn Street Chicago, IL 60601 (312) 431-6809							X		X	X	
Hazelton Environmental Sciences Corp. 1500 Front Age Road Northbrook, IL 60062 (312) 564-0700					X	X					
IIT Research Institute 10 West 35th Street Chicago, IL 60616 (312) 567-4000	X	X	X	X	X	X					
Interlake Technical Center, Inc. 150 W. 137th Street Chicago, IL 60627 (312) 849-2500, Ext. 2788				X	X						
Jon Peacy Consultants 1770 Sunnyside Highland Park, IL 60035 (312) 831-4224				X							
NATLSCO of Kemper Corp. Kemper Center, Rt. 22 Long Grove, IL 60049 (312) 540-3104				X	X						
Occusafe, Inc. 1040 Milwaukee Avenue Wheeling, IL 60090 (312) 459-4800				X							
Phoenix Chemical Laboratories, Inc. 3953 Shakespearce Avenue Chicago, IL 60647 (312) 772-3577	X			X	X						
Randolph & Associates, Inc. 8901 N. Industrial Road Peoria, IL 61615 (309) 692-4422				X	X						

TABLE 14

Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing			Air Monitoring	Air Sample Quantification		Removal	Disposal	Encapsulation	Enclosure	Marking
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy		Optical Microscopy (NIOSH) Method	Electron Microscopy					
Region V:											
Circle B Company, Inc. 8463 Castlewood Drive Indianapolis, IN 46250 (317) 849-5640	X	X	X	X	X	X	X	X	X	X	X
TenEch Environmental Consultants Inc. 744 W. Washington Street South Bend, IN 46601 (219) 234-1166	X	X	X	X	X	X					
Valley Insulation Co., Inc. 2104 N. Lynn Street Mishawaka, IN 46544 (219) 259-5627							X	X	X		
Clayton Environmental Consultants, Inc. 25711 Southfield Road Southfield, MI 48075 (313) 424-8860	X	X	X	X	X	X					X
Energy-Seal Company P.O. Box 467 Lake Orion, MI 48035 (313) 332-2424	X	X			X				X	X	
Environmental Control Technology Corp. 3983 Research Park Ave. Ann Arbor, MI 48104	X										
Environmental Health Laboratory 32740 Northwestern Hwy. Farmington Hills, MI 48018 (313) 626-2426		X		X	X						
Environmental Research Group, Inc. 117 N. First Street Ann Arbor, MI 48104 (313) 662-3104		X		X	X						
Great Lakes Systems, Inc. 2286 Port Sheldon Road/ P.O. Box 6 Jenison, MI 49428 (616) 66[illegible]-5300									X		
Industrial Coatings, Inc. Box 63C Rogers, MN 55374 (612) 428-4131							X		X		
MMT Environmental, Inc. 4643 N. Chatsworth Street St. Paul, MN 55112 (612) 483-0956	X	X	X	X	X	X					

TABLE 14

Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing			Air Monitoring	Air Sample Quantification		Removal	Disposal	Encapsulation	Enclosure	Marking
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy		Optical Microscopy (NIOSH) Method	Electron Microscopy					
Region V:											
St. Paul Fire & Marine Insurance Company Environmental Services Analytical Lab. 494 Metro Square Bldg. 7th & Roberts Streets St. Paul, MN 55101 (612) 221-7911	X	X									
St. Paul Risk Services, Inc. 424 Hamm Building 408 St. Peter Street St. Paul, MN 55102 (612) 221-7990	X	X		X	X						
Battelle Columbus Lab. 505 King Avenue Columbus, OH 43201 ATTN: Ms. Janice L. Patton (614) 424-4642	X										
Bruce Menkel and Associates, Inc. 2242 W. Schantz Avenue Dayton, OH 45409 (513) 298-7479				X							
Dr. Lester J. Walters, Jr Dept. of Geology Bowling Green Univ. Bowling Green, OH 43403 (419) 372-2886	X										
Frank Novak & Sons, Inc. 23940 Miles Road Cleveland, OH 44128 (216) 475-5440									X		
Herron Testing Labs, Inc. 5405 Schaaf Road Cleveland, OH 44131 (216) 524-1450	X	X		X	X						
Kettering Laboratories/ Analytical Center Univ. of Cincinnai Medical Center 3223 Eden Avenue Cincinnati, OH 45267 (513) 872-5739	X				X						
Monsanto Research Corp. P.O. Box 8, Station B Dayton, OH 45407 (513) 268-3411	X			X	X						
PEDCo Environmental, Inc. 11499 Chester Road Cincinnati, OH 45246 (513) 782-4707 or (513) 782-4807	X	X			X						

TABLE 14

Region No.: Name & Address of Laboratories or Contractors Telepnone Number	Bulk Testing				Air Sample Quantification						
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy	Air Monitoring	Optical Microscopy (NIOSH) Method	Electron Microscopy	Removal	Disposal	Encapsulation	Enclosure	Marking
Region V:											
Pittsburg Testing Lab. 1715 Brockpark Road Cleveland, Ohio (216) 749-3655	X										
Pollution Control Sciences, Inc. 6015 Manning Road Miamisburg, OH 45342 (513) 866-5908	X	X		X	X	X	X	X	X	X	
Seagull Environmental Control 200 West 5th Street Dayton, OH 45402	X				X		X	X	X	X	X
Dittloff Engineering Co. 101 N. Main Street River Falls, WI 54022 (715) 425-9381							X	X	X	X	X
Environmental Technolcgy & Engineering Corp. 13020 W. Bluemound Rd. Elm Grove, WI 53122 (414) 784-2434				X	X	X					
Paul J. Lynch & Assoc. P.O. Box 2322 2130 S. 22nd Street LaCrosse, WI 54601 (608) 788-4579	X			X	X						
Sentry Insurance 1800 North Point Drive Stevens Point, WI 54481 (715) 346-6000	X			X	X						
Sommer-Frey Lab., Inc. 6125 W. National Ave. West Allis, Wisconsin (414) 475-6700					X						
Wausau Insurance Company 2000 Westwood Drive Wausau, WI 54401 (715) 845-5211	X	X			X						
Region VI:											
A.S.I. Rt. 2, Box 173 Hampton, AK 71744 (501) 798-4418							X	X	X	X	X
Hampton Construction 1010 Dogwood Street Magnolia, AK 71753									X		
D&D Insulators 831 Drago West Monroe, LA 71291 (318) 388-3100							X	X	X	X	X

TABLE 14

Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing			Air Monitoring	Air Sample Quantification		Removal	Disposal	Encapsulation	Enclosure	Marking
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy		Optical Microscopy (NIOSH) Method	Electron Microscopy					
Region VI:											
K-13 SprayOn Systems of Baton Rouge, Inc. 1115 South 14th Street Baton Rouge, LA 70802							X	X	X	X	X
Sunbelt Associates, Inc. 6961 Mayo Road New Orleans, LA 70126 (504) 242-5026 or (504) 283-0325	X	X			X						
Keers, Inc. 3323 Stanford, N.E. Albuquerque, NM 87107 (505) 345-3531							X	X	X		
Mauser-Daubert-Williams, Inc. 1648 S. Boston Avenue Tulsa, OK 74419 (918) 584-0347							X	X	X	X	X
Spray Insulators of Oklahoma 100 N.E. 26th Street Box 716 Oklahoma City, OK 73101							X		X		
Analytical Center, Inc. P.O. Box 15635 6001 Clinton Drive Houston, TX 77020 (703) 676-0141	X	X	X		X	X					
Brooks Occupational Health Laboratory/SA Brooks AFB, TX 78235 (512) 536-3626	X										
C & I, Inc. 5427 Gessner Drive Houston, TX 77041 (713) 466-4474				X			X	X	X	X	X
Chestnut Construction Co. Rt. 4, Box 4231 Y Belton, TX 76513 (817) 939-7706							X	X	X	X	X
Foster Products Division of H.B. Fuller Company 6107 Industrial Way Houston, TX 77011 (800) 231-9541									X		
Fuller-Austin Insulation Company P.O. Box 363051 5605 Hillcrest Avenue Houston, TX 77035 ATTN: Marion McManus							X	X	X	X	

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Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing			Air Monitoring	Air Sample Quantification		Removal	Disposal	Encapsulation	Enclosure	Marking
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy		Optical Microscopy (NIOSH) Method	Electron Microscopy					
Region VI:											
Goodpaster's Air Control, Inc. 1442 Kyle Road Clute, TX 77531							X	X	X	X	X
Institute for Research, Inc. 8330 Westglen Drive Houston, TX 77063 (713) 783-8400	X	X	X	X	X	X					
Molecular Structure Corp. 3304 Longmire Drive College Station, TX 77840 (713) 693-9729		X									
National Cellulose Corp. P.O. Box 45006 12315 Robin Blvd. Houston, TX 77045 (713) 433-6701				X			X	X	X	X	X
Nuclear Sources & Services, Inc. P.O. Box 34042 Houston, TX 77034 (713) 641-0391								X			
Occupational Health Safety Services, Inc. 940 Kiowa Burkburnett, TX 76354 (817) 569-0456	X	X	X	X	X	X	X		X	X	X
Quest Research International, Inc. P.O. Box 478 Tyler, TX 75701 (214) 597-4174	X				X						
Southwestern Laboratory P.O. Box 87681 222 Cavalcade Houston, TX 77009 (713) 692-9151	X	X	X	X	X	X					
The Continental Insurance Company Environmental Health Division 1810 Commerce Street Dallas, TX 75201 (214) 748-7351	X	X		X	X						
White Insulation 901 Robb/P.O. Box 1470 Trinity, TX 75862									X	X	X
Region VII:											
University Hygienic Lab. The Univ. of Iowa Iowa City, IA 52242 (319) 353-5990					X						

TABLE 14

Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing				Air Sample Quantification						
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy	Air Monitoring	Optical Microscopy (NIOSH) Method	Electron Microscopy	Removal	Disposal	Encapsulation	Enclosure	Marking
Region VII:											
Sunflower Insulation P.O. Box 271 310 W. Fourth Newton, KS 67114 (316) 283-4755				X			X	X	X	X	X
D.W. Ryckman & Assoc., Inc. 2208 Welsch Industrial Court P.O. Box 27310 St. Louis, MO 63141 (314) 569-0991	X	X	X		X	X	X	X	X	X	X
Young Sales Corporation 1054 Central Industrial Drive St. Louis, MO 63110 (314) 771-3080							X	X			
Nebraska Testing Lab. 4453 S. 67th Street Omaha, NE 68106 (402) 331-4453				X	X						
Region VIII:											
Colorado School of Mines Research Institute P.O. Box 112 Golden, CO 80401 (303) 279-2581	X	X		X	X						
Coors/Spectro-Chemical Laboratory P.O. Box 500 Golden, CO 80401 (303) 278-4000		X			X						
Dale C. Wingeleth, Inc. 5401 Western Avenue Boulder, CO 80301 (303) 494-4242				X	X						
Hager Laboratories, Inc. 12000 E. 47th Avenue Denver, CO 80239 (303) 371-1441	X			X	X						
Hauser Laboratories 5680 Central Avenue P.O. Box G Boulder, CO 80306 (303) 443-4662	X	X	X	X	X	X					
Robert J. Kuryvial, Ph.D. 31720 Hilltop Road Golden, CO 80401 (303) 642-7559	X				X						
Audio-Therm 2525 Minnesota Avenue Billings, MT 59101 (406) 259-4072									X	X	

TABLE 14

Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing				Air Sample Quantification						
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy	Air Monitoring	Optical Microscopy (NIOSH) Method	Electron Microscopy	Removal	Disposal	Encapsulation	Enclosure	Marking
Region VIII:											
American Chemical & Research Laboratories 1401 West 820 North Provo, UT 84601 (801) 375-9100	X	X	X		X	X	X	X	X	X	X
UBTL Division/Univ. of Utah Research Inst. 520 Wakara Way Salt Lake City, UT 84108 (801) 581-8267 or (801) 581-5277	X	X			X						
Department of Agriculture Chemical & Bacteriological Laboratory P.O. Box 3228 University Station Laramie, WY 82071					X						
Occupational Health & Safety The State of Wyoming Cheyenne, WY 82002 (307) 777-7786				X							
Region IX:											
Collier Insulation Co., Inc. 3789 Grand Avenue Phoenix, AZ 85019 (602) 246-0308									X		
Analytical Research Labs., Inc. 160 Taylor Street P.O. Box 369 Monrovia, CA 91016 (213) 357-3247	X			X	X						
Asbestos Removal & Sealant Company P.O. Box 142 Santa Clara, CA 95052 (408) 279-4193							X		X		
Brunk Insulation 6101 Stoddard Road Oakdale, CT 95361 (209) 847-5941							X	X	X	X	
C.E.D. Inc. 530 W. Cutting Road Richmond, CA 94804 (415) 234-3761	X										
Certified Testing Laboratories, Inc. 2905 E. Century Blvd. South Gate, CA 90280 (213) 564-2641	X	X		X	X						

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Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing				Air Sample Quantification						
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy	Air Monitoring	Optical Microscopy (NIOSH) Method	Electron Microscopy	Removal	Disposal	Encapsulation	Enclosure	Marking
Region IX:											
EMS Laboratories 12517 Crenshaw Blvd. Hawthorne, CA 90250 (213) 973-6694	X	X	X	X	X	X					
Environmental Analysis Laboratories LFE Corporation 2030 Wright Avenue Richmond, California (415) 235-2633	X	X	X	X	X	X	X	X	X	X	
HCL Division/Safety Specialists, Inc. 3284F Edward Avenue Santa Clara, CA 95050 (408) 988-1137				X			X	X	X	X	X
Health Science Assoc. 10941 Bloomfield Street Suite B/C Los Angeles, CA 90720 (213) 430-1031	X			X	X						
Radiation Detection Co. 162 Wolfe Road P.O. Box 1414 Sunnyvale, CA 94088 (408) 735-8700				X	X						
Associated Insulation Company, Ltd. 524 Cooke Street Honolulu, HI 96813 (808) 531-8161									X		
Brewer Analytical Chemical Laboratory 311 Pacific Street Honolulu, HI 96817 (808) 533-4411	X			X	X						
Casalina Assoc., Inc. 47-345 Mahakea Road Kaneoke, HI 96744 (808) 239-6514	X	X	X		X	X					
Coastal Insulation, Inc. 98-025 Hekaha Street Aiea, HI 96701 (808) 487-7277 (& 7278)							X	X	X	X	X
Haas Insulation Inc. 1533 Kaminaka Drive Honolulu, HI 96816 (808) 737-3495									X		
Pacific Marine & Supply Company, Ltd. Pier 13 Honolulu, HI 96817 (808) 841-7614 or (808) 531-0182									X		

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Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing			Air Monitoring	Air Sample Quantification		Removal	Disposal	Encapsulation	Enclosure	Marking
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy		Optical Microscopy (NIOSH) Method	Electron Microscopy					
Region IX:											
The Industrial Analytical Laboratory 1523 Kalakawa Avenue Suite 207 Honolulu, HI 96826 (808) 949-6191	X	X	X	X	X	X					
Big West Insulation, Inc. 1009 South Main Street Las Vegas, NV 89101							X		X	X	
Region X:											
G & G Insulation Service 8618 Franklin Road Boise, Idaho 83705 (208) 375-9180									X		
MEI Charlton, Inc. 2233 S.W. Canyon Road Portland, OR 97201 (503) 228-9663	X		X		X	X					
Northwest Testing Laboratories 4115 N. Mississippi Ave. Portland, OR 97217	X										
Boeing Commercial Appliance Company P.O. Box 3707 Seattle, WA 98124	X										
Chem-Nuclear Systems, Inc. P.O. Box 1866 Bellevue, WA 98009 (206) 827-0711								X			
Department of Environmental Health Univ. of Washington SC34 Seattle, WA 98195 (206) 543-4252				X							
Economy Insulation Spray, Ltd. 414-1200 Westlake Ave.,N. Seatle, WA 98109 (206) 283-8875									X		
Environmental Health Sciences 805 Goethals Drive Richland, WA 99352 (509) 943-0802	X	X		X	X						
Northwest Laboratories 1530 First Ave., South Seattle, WA 98134 (206) 622-0680 or (206) 242-0367				X							

TABLE 14

Region No.: Name & Address of Laboratories or Contractors Telephone Number	Bulk Testing			Air Monitoring	Air Sample Quantification		Removal	Disposal	Encapsulation	Enclosure	Marking
	Petroscopic Microscopy	X-Ray Diffraction	Electron Microscopy		Optical Microscopy (NIOSH) Method	Electron Microscopy					
Region X:											
Makus Development Corp. P.O. Box 31 Mercer Island, WA 98040 (206) 641-7373									X		
The E.J. Bartells Co. 700 Powell Avenue, S.W. Renton, WA 98055 (206) 228-4111							X				
The Energy Savers, Inc. Evans Industrial Park 1466 127th Pl., N.E. Bellevue, WA 98005 (206) 453-8013							X		X		
Ventilation Power Cleaning, Inc. 3914 Leary Way, N.W. Seattle, WA 98107 (206) 634-2750							X				
Vertecs Corporation P.O. Box 675 Kirkland, WA 98033 ATTN: Mr. Dale Shinman							X				

TABLE 15

REGIONAL AVAILABILITY OF CONTRACTORS -
NUMBER (PERCENT OF TOTAL)

Region No.	Bulk Testing			Air Monitoring	Air Sample Quantification		Removal	Disposal	Encapsulation	Enclosure	Marking
	PLM	XRD	EM		OM (NIOSH)	EM					
I	9(8.08%)	7(9.86%)	7(17.5%)	14(15.05%)	11(10.00%)	7(15.55%)	8(16.59%)	6(16.59)	7(8.75%)	6(13.95%)	5(16.13%)
II	14(13.21%)	11(15.49%)	3(7.50%)	13(13.98%)	13(11.82%)	4(8.89%)	10(14.49%)	5(10.20%)	13(16.25%)	2(4.65%)	1(3.22%)
III	10(9.43%)	6(8.45%)	4(10.00%)	12(12.90%)	12(10.91%)	4(8.89%)	8(1.59%)	5(10.20%)	8(10.00%)	3(6.09%)	2(6.45%)
IV	12(16.32%)	4(5.63%)	2(5.00%)	7(7.53%)	10(9.09%)	1(2.22%)	9(13.04%)	7(14.28%)	8(10.00%)	5(11.63%)	4(12.90%)
V	24(22.64%)	16(22.53%)	6(15.00%)	22(23.65%)	26(23.64%)	9(20.00%)	8(11.59%)	6(12.24%)	11(13.75%)	7(16.28%)	4(12.90%)
VI	14(13.21%)	13(18.31%)	8(20.00%)	6(6.45%)	13(11.82%)	10(22.22%)	12(17.39%)	11(22.45%)	15(18.75%)	11(25.58%)	10(32.26%
VII	3(2.83%)	2(2.82%)	2(5.00%)	2(2.15%)	4(3.64%)	2(4.44%)	3(4.35%)	3(6.12%)	2(2.50%)	2(4.65%)	2(6.45%)
VIII	6(5.66%)	5(7.04%)	2(5.00%)	5(5.38%)	9(8.18%)	2(4.44%)	1(1.45%)	1(2.04%)	2(2.50%)	2(4.65%)	1(3.22%)
IX	10(9.43%)	6(8.45%)	5(12.50%)	9(9.68%)	10(9.09%)	5(11.11%)	6(8.69%)	4(8.16%)	10(12.50%)	5(11.63%)	2(6.45%)
X	4(3.77%)	1(1.41%)	1(2.50%)	3(3.22%)	2(1.82%)	1(2.22%)	4(5.80%)	1(2.04%)	4(5.00%)	0(0)	0(0)
TOTAL	106(100%)	71(100%)	40(100%)	93(100%)	110(100%)	45(100%)	69(100%)	49(100%)	80(100%)	43(100%)	31(100%)

NOTES: PLM = Polarized Light Microscopy
XRD = X-Ray Diffraction
EM = Electron Microscopy
OM = Optical Microscopy

NOTE: Due to relatively high response rate(30%), and extensive survey coverage (646 firms), percentage figures are expected to be representative of the universe of firms providing these services.

III. ESTIMATION OF AFFECTED SCHOOL DISTRICT POPULATION

This chapter presents the results of our efforts to develop population estimates of the number and degree to which school districts, schools, and students may be affected by the possible voluntary actions to control asbestos in schools. The following sections discuss the methodological steps used to develop population estimates. The steps include choosing a sample of school districts, clustering and subsequent stratification of the universe of school districts, collecting the data required for the completion of this project, and, finally, development of the parameters needed for the population estimates. The discussion of population estimates is followed by a discussion of the limitations of these results.

1. DETAILED METHODOLOGICAL DISCUSSION

This section discusses the methodological steps which were used to develop the parameters by which population estimates were derived.

(1) Choice of Initial Sample of EPA Returns

It was jointly decided by EPA and Arthur Young & Company that this project should use data provided by the EPA regional offices from material obtained through the EPA Voluntary Program. These returned forms provided a sample which contained a significant portion of the data required by the study. Therefore, it would be relatively easier to complete the data requirements by obtaining the additional data in a follow up study to the original EPA Voluntary Survey (OMB No. 158-R-0165). The time constraints of this study made this an important consideration. The limitation of using these data, however, is that they may not represent the total population of school districts. The bias could be that these respondents may have uncharacteristically active asbestos control programs, evidenced by their relatively early response to the survey. Of the approximately 550 forms returned by November 19, 1979, 401 were used as the initial sample. Usable forms were those of school districts which could be identified as a public school system based on a tape of Public School Systems from the National Center for Education Statistics, Department of Education. Unusable survey forms, for the purposes of this study, were those from Head Start Programs, private schools, and from individual public schools.

(2) Choice of Cluster Variables

The population of public school systems is large (over 16,000 school districts) and very heterogeneous. It was evident at the outset that any meaningful analysis would require a segmentation of this universe into more homogeneous sets (clusters). This was effected by identifying school district characteristics (variables) which may govern the cost of compliance with the proposed regulation. Practical considerations stipulated that any data for the variables chosen be easily obtained. The time and resource limitations of the project prevented a more thorough analysis for potentially the best variables to use. The variables chosen were EPA Region code, metro code (indicating the degree of urbanization of the school district) (MTS), number of schools built between 1945 and 1978 (NBLT), and the number of students enrolled in each school district (NST).

"EPA region" signifies in which section of the country a school district is located. School districts on the East coast may, for instance, have more in common in terms of the cost of labor required for certain control actions than with school districts in the central and western parts of the United States. Determining geographic location by individual states would have created a minimum of fifty sections of the country which would have to be analyzed. This would have made any analysis much more cumbersome instead of easier.

The metro code (MTS) is a numeric code identifying the Standard Metropolitan Statistical Area (SMSA) in which (or near which) the school district is located. The code identifies districts within city limits (MTS = 1), within SMSA, but outside city limits (suburbia, MTS = 2), and all other or outside SMSA (rural, MTS = 3). The metro code divides EPA regions into smaller geographical areas in which there would be a similarity of age and structure of a school building. For example, the age and structure of a school built in an inner-city area might be different from a school building in a suburban or rural area. Both of these factors are potentially important cost-influencing factors.

The number of schools built or renovated between 1945 and 1978 (NBLT) was chosen because the probability of a school having asbestos containing material is greater in schools which were built or renovated between 1945 and 1978. It was during this time period that the asbestos-containing materials were used the most.

The number of students in a school district is an indication of the size of the school district and the magnitude of the asbestos problem if asbestos containing materials are present. It is also related to the size of the school budget and, therefore, the amount of funds potentially available for use in asbestos detection and voluntary control actions.

The EPA Region, metro code (MTS) and number of students in a school district (NST) were obtained from the Public School Systems tape from the National Center of Education Statistics. The number of schools built or renovated between 1945 and 1978

(NBLT) was partially obtained from contacting each State Department of Education. In instances where this information was unavailable, the assumption was made that all schools in that state had either been built or had major renovations since 1945.

(3) Cluster Analysis and Stratification

As mentioned earlier, any meaningful regulatory cost analysis would require segmentation of the universe into homogeneous groups based on variables which could affect the cost of complying with the proposed regulation. Cluster analysis was used to define a suitable range for each variable for purposes of stratification.

The clustering process groups school districts based on a distance criterion. [1] Distance is measured by the Euclidean distance (the square root of the sum of squares of the differences between the values of the variables for each pair of cases). The variables whose values were used were the metro code (MTS), the number of schools built between 1945 and 1978 (NBLT), and the number of students in a school district (NST). The location variable, EPA region, was not used at this point because the distance between numbers is not meaningful numerically. For example, the distance between Regions I and II has no relationship to the distance between Regions II and III.

Each school district is initially placed in a cluster by itself. At each step in the clustering process, the two clusters with the shortest distance between them are combined into one cluster. This process of combining clusters continues until all of the cases are combined into a prespecified number of clusters.

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[1] Engleman, Laszlo. Biomedical Computer Programs P-Series; 17.2 Cluster Analyses of Cases. (University of California Press, 1979) p. 633.

The cluster analysis algorithm sometimes considers outliers as a distinct cluster. These outliers usually consist of only one or two cases. As these are usually too small to be useful, they are disregarded.

From each cluster the ranges of the values of each variable were individually measured. In this manner, the dividing point between clusters for each variable is discerned and the concept of how the population could be stratified into homogeneous units is derived.

The clusters were developed without the location variable, EPA region, which meant that each cluster included school districts from the entire United States. It had been assumed that geographic location would affect the cost of the labor required for certain voluntary corrective actions. To divide each cluster into smaller geographic areas, the EPA region variable was added at this point. Each cluster was divided into smaller geographic regions. The values of the other variables remained the same. Now, however they identified school districts within certain geographic boundaries rather than the entire United States. The geographic breakdown consisted of East coast (Regions I-V), Central (Regions VI-VIII), and the West coast (Regions IX-X), which included Alaska and Hawaii. This particular breakdown was decided upon because it expanded the number of clusters only threefold and enabled states for which no data were available to be averaged in with similar states for which data were available. If smaller EPA region groups or individual states had been used, the number of clusters developed would have been too cumbersome to have been analyzed easily.

(4) Bias Adjustments

Bias in the EPA voluntary survey sample could occur for one or more of the following reasons:

- Small sample size. The initial sample of 401 was approximately 2.5% of the total population of school districts.

- Due to time and budgetary constraints, the clustering process was limited to 250 records from the original 401. The records that were chosen for clustering were the 250 most classifiable records based on the chosen cluster variables. By excluding 151 records additional biases may have been introduced. This reduction also aggravated the small sample size problem reducing the sample from 2.5% of the population to 1.6% of the population.

- By design, the initial sample consisted entirely of school districts who responded to the EPA voluntary survey form.

In order to qualitatively ascertain if there were any strong biases, a small sample of 20 non-respondents was randomly chosen and contacted by telephone. The purpose of the telephone inquiries was to generally determine if the asbestos information sent in by respondents differed from information obtained from non-respondents. An EPA voluntary survey form was filled out for each of the school districts contacted.

The data collected were visually compared with information from respondents. Items from the EPA voluntary survey were used for comparison. It was noted that the asbestos specific information was generally similar. Noted also was that the ranges of some of the cluster variables were restrictive resulting in the exclusion of non-respondent school districts from the established clusters. For instance, the ranges for NBLT were 1-4 and 6-10. This excluded cases where 5 schools per school district were built or renovated or where more than 10 schools per school district were built or renovated. Also excluded from the established clusters were school districts in inner city areas (MTS = 1). This particular exclusion was due to the fact that the first 250 classifiable school districts clusters were only rural (MTS = 3) and suburban (MTS = 2) school districts.

Adjustments to the clusters were made to correct for the exclusion of school districts mentioned above. The ranges of the variables were extended using information obtained from the above survey testing bias and from the original clusters. These changes made it possible for the clusters to represent more of the population. The changes made to the ranges of the variables are as follows:

- NST

  The students enrolled in school districts were originally divided into groups of 516 - 2700 and 3137 - 8807. These ranges were restrictive as there are over 4000 school districts with less than 300 students. The ranges were changed to 1-2499 and 2500 and greater students in a school district.

- MTS

  Inner city area schools were totally excluded from the original cluster. These school districts generally have more than 10,000 students enrolled and the majority of their schools have either been built or have had extensive renovations between 1945 and 1978. These school districts are also at the upper end of the ranges for NBLT and NST. Therefore, all inner city schools were placed in one cluster. This cluster was further divided into five clusters based on EPA regions when it was discovered that this would make the analysis of these school districts more meaningful due to the variation in degree affected within units of that cluster.

After the changes to the ranges of variables were made, the original clusters, which represented only about 25% (4,000) of the school districts, were extended to represent over 15,800 school districts (99%). The remaining 1% consisted of school districts in United States territories.

In general, if a cluster represented less than 0.4% (approximately 70 districts) of the total population, it was considered too small to be sampled as the analysis would not be meaningful. This eliminated 5 (345 school districts) of the 25 clusters. The range of variables in each cluster is presented in Exhibit 4. The final population of school districts which are represented by the remaining 20 clusters consists of approximately 15,746 school districts (98% of the school district universe).

As each cluster represented a unique group of school districts in the population, it was necessary to have each cluster adequately represented in the sample on which detailed information would be collected. A minimum sample size of 1% of each population cluster was set. It was necessary to limit the sample size due to the time and resource limitations of the project.

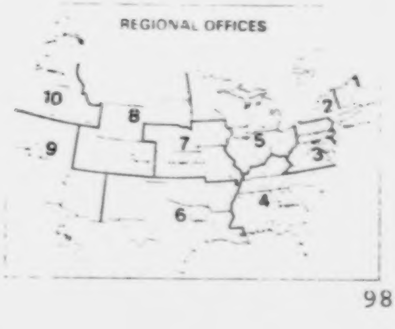
The school districts chosen for the sample on which detailed information would be collected were comprised of respondents and

Composition of Population Strata

EXHIBIT 4

Population Strata	Metro Code	EPA Region	Number of Schools Built between 1945 & 1978 per School District	Number of Students per School District	Number of School Districts in Population
1	3	1 - 5	≤ 5	≥ 1 and ≤ 2499	3105
2	3	6 - 8	≤ 5	≥ 1 and ≤ 2499	4650
3	3	9 - 10	≤ 5	≥ 1 and ≤ 2499	1011
4	3	1 - 5	≥ 6	≥ 2500	670
5	3	6 - 8	≥ 6	≥ 2500	224
6	3	6 - 8	≤ 5	≥ 2500	69
7	3	9 - 10	≤ 5	≥ 2500	51
8	2	1 - 5	≤ 5	≥ 1 and ≤ 2499	1733
9	2	6 - 8	≤ 5	≥ 1 and ≤ 2499	684
10	1	1 - 10			349
11	2	9 - 10	≤ 5	≥ 1 and ≤ 2499	547
12	3	6 - 8	≥ 6	≥ 1 and ≤ 2499	68
13	2	6 - 8	≥ 6	≥ 2500	156
14	[illegible]	9 - 10	≥ 6	≥ 2500	267
15	[illegible]	1 - 5	≥ 6	≥ 1 and ≤ 2499	216
16	[illegible]	9 - 10	≥ 6	≥ 2500	81
17	2	1 - 5	≥ 6	≥ 2500	862
18	[illegible]	1 - 5	≤ 5	≥ 2500	669
19	2	9 - 10	≤ 5	≥ 2500	70
20	2	1 - 5	≤ 5	≥ 2500	372
					15,854

EPA Regions



Metro Code:
1 = District within City Limits
2 = District within SMSA outside City
3 = All other or District outside SMSA

non-respondents to the EPA voluntary survey. The original sample of 401 EPA voluntary survey respondents was stratified using the ranges of variables established for each population cluster. This indicated how many clusters in the population could be adequately represented in the sample using these respondents. In only two clusters were several non-respondents included. To be assured of an adequate amount of returns for each cluster, a random sample consisting of two to three times the prescribed number of units was drawn from each of the final clusters.

The final sample consisted of 300 school districts. Responses were obtained from 246 school districts in 33 states. Eighteen of these states had more than 1% of their school districts represented in the sample.

(5) Data Collection

A review of the voluntary survey forms led to the conclusion that many were not complete and that the data given were not adequate to respond to the requirements of this study. These forms would indicate that inspections were done and/or bulk samples taken but not the results of these activities. In other cases, the survey indicated an exposure problem, but did not indicate the number of square feet affected and/or the number of students affected.

A telephone survey was conducted to obtain the necessary data. Letters were sent to superintendents of the school districts and maintenance personnel about ten days in advance of phone calls stating the purpose and information requirements of the survey. The following data were requested from the maintenance personnel.

- An assessment of the schools in a school district which may require voluntary corrective action (by type of corrective action) was requested for the development of population estimates. A draft of an asbestos exposure assessment algorithm, provided by EPA, was sent for use as a standard procedure for assessing a school building. Using this algorithm, an indication of the number of buildings possibly requiring each type of voluntary corrective action could be obtained. For example, after reviewing conditions in a school district, it may be found that of ten schools, it may be recommended that three be 'encapsulated', six be 'deferred' and one would not need any further action.

- Total square footage of each affected school was obtained. This was required to develop aggregate cost estimates.

Superintendents of the school districts were requested to provide the following information on the number of affected students and on any potential negative impacts based on the maintenance superintendent's assessment of the schools in the district for which voluntary corrective action may be recommended:

- Number of schools or parts of schools which may temporarily close and the number of school days which could be lost as a result of any recommended asbestos correction activity.
- Number of schools or parts of schools where the potential may exist for permanent closure, the potential number of students that may be displaced, and the expected change in average class size and student/teacher ratio at other schools due to these possible closings.
- The number of jobs which may be lost if the asbestos problem is considered severe enough by the maintenance personnel

assessment to warrant either a long-term temporary school closing or permanent school closing.

- Any additional indirect costs (i.e., over and above the direct cost of any detection and voluntary asbestos control activities) as a result of corrective actions that may be voluntarily taken.

- The number of affected students was also requested as it was required for the development of population estimates. The number of affected students could be an entire school's population if the area in question is the cafeteria or auditorium. In other cases, affected students could be limited to those students using that particular room. An illustration would be choral students who are the only students using the band and chorus rooms.

Information obtained from the school administrators indicated that, in a number of instances, the information on the EPA survey was no longer valid. This was due in part to new information obtained by the school administrators in the interim which caused the school to be assessed differently. In other school districts, corrective action on the affected areas had either begun or had been completed.

Each school district was carefully analyzed as to the completeness and accuracy of information. In several instances, certain assumptions about the available data were made:

- Where a school had more than one type of corrective action recommended, an average of all asbestos algorithm scores of that school was used as the score for the school. For instance, a school has four areas for which corrective action is recommended. The asbestos algorithm scores for these areas are 4, 20, 40, 36, with the average being 25. Therefore, the entire school would be analyzed as needing encapsulation. This was fairly restrictive, but it was the most logical step to take, based on the information available. This was done with the concurrence of EPA.

- In some cases complete algorithm scores were not available because the bulk samples had not been returned from the laboratory or were not taken. Maintenance personnel were asked, based on their knowledge of the school through plans or specifications, whether they felt the friable material in question contained asbestos. If an affirmative answer was given, they were then asked for their estimate of the concentration of asbestos in these materials. Using their judgment in conjunction with the completed portions of the algorithm, the voluntary corrective action was determined for that school.

- Potential costs incurred in correcting boiler room areas and pipe wrappings are usually much lower than other areas needing corrective action. This can be in part due to tape being used to repair pipe jackets or just the damaged area of the pipe wrapping being replaced. Therefore, to avoid confusion in both assessing the seriousness of a problem area and the cost of other voluntary corrective actions, boiler rooms and pipes have been kept separate.

(6) Extrapolation

This section discusses the procedure used for extrapolating sample level data to the universe of school districts. Each sample cluster was analyzed as to the number of school districts, schools, and students affected by the proposed regulation. "Affected" was defined as those school districts and schools for which one or more asbestos control action may be recommended based on the asbestos exposure assessment algorithm. Students affected are those students who have had exposure to the asbestos containing materials. The number of students affected in a school depends on whether the problem area is in a cafeteria or a specialized room like the band room.

A "rate of affectedness" was constructed for each of the three areas (i.e., school districts, schools, and students) for each sample cluster (See Exhibit 5). This is used subsequently to estimate the affected population of school districts, schools, and students. Each of these rates is described below:

- The percentage of affected school districts is the ratio of those school districts in a sample cluster for which corrective action is recommended in at least one school based on the asbestos assessment exposure algorithm to the total number of school districts in that cluster.

- The percentage of affected schools is the ratio of all the schools in a sample cluster for which corrective actions are recommended to all the schools in the sample cluster.

- The percentage of affected students is the ratio between those students potentially affected by asbestos containing materials in a sample cluster to the total number of students in that same cluster.

The tally of affected students does not include students in schools where asbestos containing materials are confined to boiler rooms or pipes. It is unlikely that many students would have reason to be exposed to these areas.

Using the rates developed, population estimates of the number

The Number of School Districts, Schools, and Students in Sample Affected by Asbestos Control Measures

Sample Strata	Total School Districts in Sample	%1/	Estimate of Affected School Districts in Sample	Total Number of Schools in Sample	%2/	Estimate of Affected Schools	Total Students in School Districts	%3/	Estimate of Affected Students
1	32	31%	10	111	19%	21	43,870	12%	5,118
2	23	26%	6	65	11%	7	12,536	5%	596
3	9	33%	3	18	28%	5	6,203	0%	0
4	36	36%	13	512	20%	102	224,527	4%	9,165
5	11	64%	7	128	14%	18	65,667	11%	7,175
6	3	0%	0	38	0%	0	20,604	0%	0
7	2	50%	1	12	17%	2	8,311	0%	0
8	16	69%	11	62	35%	22	24,856	33%	8,117
9	7	14%	1	21	5%	1	9,413	0%	0
10(a) 4/	12	83%	10	812	11%	87	590,539	11%	65,893
10(b)	1	0%	0	33	0%	0	15,349	0%	0
10(c)	5	40%	2	266	2%	6	180,838	0%	0
10(d)	17	100%	2	75	24%	18	30,727	30%	9,140
10(e)	2	100%	2	163	7%	12	80,768	15%	12,027
11	15	33%	5	41	22%	9	15,475	5%	744
12	4	75%	3	19	21%	4	5,867	22%	1,285
13	4	75%	3	23	22%	5	24,208	9%	2,179
14	4	25%	1	39	3%	1	16,438	0%	0
15	3	0%	0	28	0%	0	7,112	0%	0
16	3	100%	3	32	28%	9	18,898	29%	5,414
17	23	39%	9	203	14%	28	97,996	9%	9,352
18	14	43%	6	72	19%	14	42,226	17%	7,004
19	3	33%	1	15	7%	1	9,899	6%	625
20	4	50%	2	51	57%	29	20,234	32%	6,450

1/ Percentage of Affected School Districts = $\frac{\text{Affected School Districts}_S}{\text{Total School Districts}_S}$

2/ Percentage of Affected Schools = $\frac{\text{Affected Schools}_S}{\text{Total Schools}_S}$

3/ Percentage of Affected Students = $\frac{\text{Affected Students}_S}{\text{Total Students}_S}$ This percentage excludes those schools with asbestos containing materials exclusively in the Boiler Rooms and on Pipes.

4/ Sub Strata where MTS = 1 (inner city areas),
10(a) = EPA Region 3, 10(b) = EPA Region =5,
10(c) = EPA Region 6, 10(d) = EPA Region 7, and 1
10(e) = EPA Region 9-10

EXHIBIT 5

of affected school districts, schools, and students can be derived as follows (See Exhibit 6):

- The ratio of affected school districts to total school districts in the sample cluster is multiplied by the total number of school districts in the population cluster to estimate the number of affected school districts in the population cluster.

- The percentage of affected schools in the sample cluster is multiplied by the total number of schools in the population to obtain an estimate of the number of affected schools in the population cluster.

- The percentage of affected students in the sample cluster is multiplied by the total number of students in the population cluster to obtain an estimate of the number of affected students in that cluster.

Two sets of percentages were developed for the degree to which affected schools and school districts in a cluster would be affected. "Degree affected" being defined as the specific action (inspection, bulk sampling and voluntary corrective actions) recommended in that school or school district. These are described below. Symbols used identify variables used in the next chapter.

- Percent of schools (SA_{ij}) for which a specific action is recommended is the ratio of the number of schools for which a specific control action (j) is recommended in a cluster (i) to the total number of affected schools in that cluster. This ratio indicates, on the average, what percentage of affected schools for which a specific control action is recommended (See Exhibit 7).

EXHIBIT 6

The Number of School Districts, Schools, and Students in the Population Affected by Asbestos Control Measures

Population Strata	Total School Districts in Population	% 1/	Estimate of Affected School Districts in Population	Total Number of Schools in Population	% 2/	Estimate of Affected Schools	Total Students in School Districts	% 3/	Estimate of Affected Students
1	3,105	31%	970	7,462	19%	1,412	2,691,124	12%	313,954
2	4,650	26%	1,213	9,791	11%	1,055	1,949,125	5%	92,667
3	1,011	33%	337	2,014	28%	560	504,358	0%	0
4	670	36%	242	8,420	20%	1,684	3,947,294	4%	161,125
5	224	64%	142	4,832	14%	679	1,964,797	11%	214,680
6	69	0%	0	384	0%	0	219,808	0%	0
7	51	50%	26	275	17%	46	161,997	0%	0
8	1,733	69%	1,191	4,555	35%	1,616	2,024,747	33%	661,203
9	684	14%	98	1,660	5%	79	486,436	0%	0
10(a) 4/	38	83%	32	1,566	11%	168	1,064,751	11%	118,826
10(b)	70	0%	0	3,539	0%	0	2,263,282	0%	0
10(c)	75	40%	30	2,497	2%	56	1,690,524	0%	0
10(d)	17	100%	17	954	24%	229	524,108	30%	155,922
10(e)	41	100%	41	2,415	12%	178	1,623,641	15%	241,760
11	547	33%	182	1,123	22%	246	388,863	5%	18,696
12	68	75%	51	577	21%	121	101,079	22%	22,138
13	156	75%	117	2,894	22%	630	1,919,292	9%	174,423
14	267	25%	67	4,807	3%	123	2,986,076	0%	0
15	216	0%	0	9,937	0%	0	370,299	0%	0
16	81	100%	81	1,014	28%	285	449,343	29%	4,128,730
17	862	39%	337	13,682	14%	1,887	8,159,773	9%	778,442
18	669	43%	289	4,425	19%	860	2,999,695	17%	497,557
19	70	33%	23	353	7%	24	295,536	6%	18,659
20	372	50%	186	2,491	57%	1,416	1,360,623	32%	433,726
TOTAL	15,746		5,672	91,667		13,347	40,145,871		4,032,508

1/ Percentage of Affected School Districts = $\frac{\text{Affected School Districts}_s}{\text{Total School Districts}_s}$

2/ Percentage of Affected Schools = $\frac{\text{Affected Schools}_s}{\text{Total Schools}_s}$

3/ Percentage of Affected Students = $\frac{\text{Affected Students}_s}{\text{Total Students}_s}$ This percentage excludes those schools with asbestos containing materials exclusively in the Boiler Rooms and on Pipes.

4/ Sub Strata where MTS = 1 (inner city areas),
10(a) = EPA Region 3, 10(b) = EPA Region -5,
10(c) = EPA Region 6, 10(d) = EPA Region 7, and 1
10(e) = EPA Region 8-10

EXHIBIT 7

The Number and Degree to Which the Schools in the Sample are Affected

Sample Strata	Total Affected Schools	% 1/	Inspection	% 1/	Bulk Sampling	% 1/	Removal (Includes Disposal & AO)	% 1/	Marking (Includes Re-Inspection)	% 1/	Encapsulation (Includes Marking & Re-Inspection)	% 1/	Marking of Boiler Rooms & Pipes (Includes Re-Inspection)	% 1/	Encapsulation of Boiler Rooms & Pipes (Includes Marking & Re-Inspection)	% 1/	Removal for Boiler Room
1	21	15	3	15	3			5	1	19	4	48	10				
2	7	43	3			29	2			14	1			14	1		
3	5											40	2	60	3		
4	102					8	8	15	15	1	1	73	75	3	3		
5	18					22	4	45	8	22	4			11	2		
6	0																
7	2													100	2		
8	22	55	12					4	1	32	7	9	2				
9	1											100	1				
10(a)	88					8	7	7	6	82	72			3	3		
10(b)	0																
10(c)	6											17	1	83	5		
10(d)	18							17	3	83	15						
10(e)	12					75	9			25	3						
11	9									11	1	33	3	56	5		
12	4					25	1	50	2	25	1						
13	5							40	2					40	2	20	1
14	1									100	1						
15	0																
16	9					11	1							89	8		
17	28					11	3	21	6	14	4	25	7	29	8		
18	14					7	1	50	7	14	2	29	4				
19	1			100	1												
20	29			66	19									34	10		
TOTAL	402		18		23		36		51		116		105		52		1

1/ Percentage of Affected Schools Needing a Specific Corrective Action =

$$\frac{(\text{Number of Affected Schools}_{ij})}{\text{Total Affected Schools}_i} = SA_{ij} \quad \text{Where } i=1\text{-}20$$

j=Corrective Action

- Percent of school districts (TSD_{ij}). The sample data on corrective actions were first used to define the proportion of all affected school districts in a cluster for which some type of control action may be recommended. This factor or multiplier is represented by SDA_{ij}, with i designating the cluster, and j the voluntary asbestos corrective action.

  A second factor was calculated using the total number of schools in a cluster, regardless of whether they were affected or not. This second factor or multiplier is the proportion of total school districts in a cluster for which a specific control action may be recommended. This factor is represented by TSD_{ij}.

  This factor was developed specifically to extrapolate from the school district to the state and national levels. By using a ratio which is based on the entire number of school districts per cluster, rather than the number of affected school districts, it was felt that it would be easier to construct state and national results. This is because the number of affected school districts at those levels can only be estimated, whereas, in using the total number of school districts per cluster at these levels, a better estimate can be obtained.

  The two sets of factors or multipliers are presented in Exhibits 8 and 9. In the following chapter on estimating the costs of recommended asbestos control actions, SDA_{ij} and TSD_{ij} are used to identify the proportion of school districts, and states, and the proportion in each cluster for which certain control actions may be recommended.

Extrapolated estimates of schools and school districts for which specific type of control actions may be recommended can be

EXHIBIT 8

Number of Affected School Districts in the Population Requiring Specific Corrective Action

Population Strata	Total Affected School Districts 1/	% 2/	Inspection	% 2/	Bulk Sampling	% 2/	Removal (Includes AQ & Disposal	% 2/	Marking	% 2/	Encapsulation	% 2/	Marking of Boiler Rooms & Pipes	% 2/	Encapsulation of Boiler Rooms & Pipes
1	970	67	648	10%	97			2	19	9	82	46	449		
2	1213	50	607			14	168			8	101			17	202
3	337	53	178									28	94	25	84
4	242	43	104			3	7	8	20	.3	1	32	77	3	6
5	142	23	33			5	7	11	15	8	12			4	6
6	0	-													
7	26	33	9											33	9
8	1191	59	706					3	36	18	218	9	108		
9	98	50	49									50	49		
10a	32	14	4			2	.5	2	.6	10	3			2	.5
10b	0	-													
10c	30	4	1									2	.5	3	.8
10d	17	24	4					4	.7	20	3				
10e	41	11	4			6	3			11	4				
11	182	64	117							10	18	33	61	21	38
12	51	33	17			6	9	28	14	6	9				
13	117	17	20			6	6	6	7					11	13
14	67	11	7									11	7		
15	0	-													
16	81	31	25					2	2					29	23
17	337	35	116			5	15	6	19	3	11	13	43	13	44
18	289	43	124			4	12	18	51	8	24	17	48		
19	23	-		20	5										
20	186	45	85	45	84									45	85
TOTAL	5672		2858		186		227.5		184.3		486		936.5		511.3

1/ Number of School Districts will not add up to the Total Affected School Districts. Some will require more than one corrective action and are counted twice.

2/ Percentage of School Districts Affected $\left(\sum_{k=1}^{n} \frac{\text{Percentage of Affected School Districts i j}}{\text{Total Number of Affected School Districts}} \right) = \text{SDA}ij$ Where i= 1-20
j= corrective action
k= School District

EXHIBIT 9

Percentage of School Districts in the Population Requiring Specific Corrective Action

Population Strata	Total School Districts	Inspection %2/	Bulk Sampling %2/	Removal Includes AQ & Dsposal %2/	Marking %2/	Encapsulation %2/	Marking of Boiler Rooms & Pipes %2/	Encapsulation of Boiler Rooms & Pipes %2/
1	970	21	3%		1%	3%	14%	
2	1213	13		4%		2%		4%
3	337	18					9%	8%
4	242	16		1%	3%	.1%	11%	1%
5	142	15		3%	7%	5%		2%
6	0							
7	26	17						17
8	1191	41			2	13	6	
9	98	7					7	
10a	32	11		1%	2	8		1
10b	0							
10c	30	2					1	1
10d	17	24			4	20		
10e	41	11		6		11		
11	182	21				3	11	7
12	51	25		4	21	4		
13	117	17		4	5			8
14	67	3					3	
15	0							
16	81	31			2			29
17	337	17		2	2	1	5	5
18	289	18		18	8	4	7	
19	23		7					
20	186	23	23					23
TOTAL	5672							

1/ See footnote 5 in Exhibit

2/ Percentage of Total School Districts $= \left(\frac{\sum_{k=1}^{n} \text{\% Affected School Districts } i\,j}{\text{Total Number of School Districts } i\,j} \right) = \text{TSD}ij$

Where i= 1-20
j= corrective action
k= School District

derived in a manner similar to the one for population estimates above. The above school and school district level rates, SA_{ij} and SDA_{ij} are multiplied by the estimated population of total affected schools and school districts to develop these estimates. (See Exhibits 8,9 and 10).

2. RESULTS

The population estimates for the number of school districts, schools and students affected for the individual clusters are presented in Exhibit 5. Affected school districts and population being defined as those for which at least one type of control action is recommended. Affected students are those students exposed to asbestos-containing material. National estimates of affected population are as follows:

- School Districts: 5,672
- Schools: 13,347
- Students: 4,032,508.

The estimate for total school districts affected can also be divided according to the degree to which they are affected. The number of affected school districts will not add up to the total as some school districts may have more than one control action recommended. Estimates of school districts by type of recommended corrective action are as follows:

- Inspection: (includes initial inspection and re-inspection): 2858
- Bulk sampling: 186
- Removal (which includes disposal and air quantification): 227.5

EXHIBIT 10

The Number and Degree to Which the Schools in the Population are Affected

Population Strata	Total Affected Schools	% 1/	Initial Inspection	% 1/	Bulk Sampling	% 1/	Removal (Includes Disposal & AO)	% 1/	Marking (Includes Re-Inspection)	% 1/	Encapsulation (Includes Marking & Re-Inspection)	% 1/	Marking of Boiler Rooms & Pipes (Includes Re-Inspection)	% 1/	Encapsulation of Boiler Rooms & Pipes (Includes Marking & Re-Inspection)	% 1/	Removal for Boiler Room
1	1412	15	202	15	202			5	67	19	269	48	672				
2	1055	43	452			29	301			14	151			14	151		
3	560											40	224	60	336		
4	1677					8	132	15	247	1	16	73	1233	3	49		
5	679					22	151	45	302	22	151			11	75		
6	0																
7	46													100	46		
8	1616	55	882					4	73	32	514	9	147				
9	79											100	79				
10(a)	168					8	13	7	12	82	137			3	6		
10(b)	0																
10(c)	56											17	9	83	47		
10(d)	229							17	38	83	191						
10(e)	178					75	133			25	45						
11	246									11	27	33	82	56	137		
12	121					25	30	50	61	25	30						
13	630							40	252					40	252	20	126
14	123													100	123		
15	0																
16	285							11	32					89	253		
17	1887					11	202	21	404	14	270	25	472	29	539		
18	860					7	61	50	430	14	123	29	246				
19	24			100	24												
20	1416			66	928									34	488		
TOTAL	13347		1536		1154		1023		1918		1924		3164		2502		126

1/ Percentage of Affected Schools Needing a Specific Corrective Action =

$$\frac{(\text{Number of Affected Schools}_{ij})}{\text{Total Affected Schools}_i} = SA_{ij} \quad \text{Where } i = 1\text{-}20, \; j = \text{Corrective Action}$$

- Marking: 184
- Encapsulation: 486
- Marking of Boiler Rooms and Pipes: 936.5
- Encapsulation of Boiler Rooms and Pipes: 511

The estimate for total public schools affected can also be divided according to the degree to which they are affected. These estimates are as follows:

- Initial Inspection: 1536
- Bulk Sampling: 1154
- Removal (Which includes disposal and air quantification): 1023
- Marking (Includes reinspection): 1918
- Encapsulation (Includes marking and reinspection): 1924
- Marking of Boiler Rooms and Pipes (Includes reinspection): 3164
- Encapsulation of Boiler Rooms and Pipes (Includes marking and reinspection): 2502
- Removal for Boiler Room Asbestos: 126.

3. LIMITATIONS OF DATA AND RESULTS

The data developed in this task have limitations which affect the reliability of the above population estimates. The limitations which have been mentioned throughout this section are reiterated in the following paragraphs:

- Perhaps the most important limitation concerns the method by which sample school districts were chosen and the size of the sample. The sample was chosen, as previously mentioned, from the group of school districts who responded to EPA's asbestos survey. This suggests a bias in that this small group of respondents may have uncharacteristically active asbestos control programs. A survey of non-respondents was conducted to attempt to determine if respondents were representative of the total population. This survey did indicate areas of bias for which corrective measures were taken, but it was qualitative at best and, therefore, could not conclusively state whether bias existed.

- Even if it could be proven that the above respondents did not present an inordinately skewed picture of the population, the size of the sample does not impart statistical rigor to our estimates. As stated earlier, it represents only 1.6% of a population of about 16,000 school districts.

- The variables that formed the bases for stratification were chosen based on two conclusions. The first is that they may affect the cost of complying with the regulation. The second was a practical consideration that any data that are used be readily available for the universe of school districts. The time and resource constraints of this project made this important. Therefore, certain potential variables, such as weather, age of buildings, and even a more accurate location indicator could not be included.

- There is a good likelihood of inconsistency in the application of the asbestos exposure assessment algorithm. The algorithm assumes that everyone using it will recognize a situation for analysis and be consistent in the assessment of that situation. This may not have been a valid assumption in all cases, partly because the algorithm is somewhat subjective, and partly because people inspecting the schools for friable, potential asbestos-containing materials vary from health and EPA inspectors to superintendents who may not have an adequate technical background.

- Finally, there is the possibility of data unreliability due to incomplete test results. As was mentioned before, some algorithm scores were incomplete due to pending bulk tests. A decision, for the purposes of analysis, was made in these cases, using the judgment of the maintenance personnel as a guide. While necessary, the judgments, if made incorrectly, could skew the population estimates.

The estimates presented should not be taken as statistically rigorous due to the limitations mentioned above. They are presented, however, as ballpark numbers which could be useful to EPA decision-makers in determining the relative cost implications of the various recommended asbestos control actions.

IV. ESTIMATION OF TOTAL COSTS AND IMPACTS OF VOLUNTARY ASBESTOS CONTROL ACTIONS

This chapter presents the estimates of total costs and other impacts associated with the various asbestos control activities. Total costs are identified by cluster and individual asbestos control actions at the school district, state, and national levels. Other impacts analyzed are:

- Community impacts including possible student displacements, change in class size, school days lost (loss due to non-availability of part or all of a school because of corrective activities), change in student/teacher ratios, school closings, and job loss
- Financial burdens on the most heavily impacted school districts in the study sample
- Sources of state, local, and federal funds or assistance available to school districts to meet the cost of asbestos corrective action(s)
- Positive community impacts which include the estimated number of students and teachers removed from asbestos risk; and the estimated number of jobs created to control asbestos due to the intended EPA regulation.

This chapter begins with a definition of the data sources used and a discussion of adjustments made to the data for use in deriving cost estimates. This section is followed by a description of the methodology used to develop school district cost estimates, and extrapolate these estimates to the state and national levels. The final section of the chapter reviews other impacts related to the voluntary control actions including the operational impacts on school districts, budget impacts, and positive impacts such as new jobs created, and the number of students and teachers removed from asbestos risk.

1. COST ESTIMATES BY SAMPLE CLUSTERS

This section reviews how estimates developed in Chapters II and III were adjusted and formulated into school district cost estimates for control actions. The remainder of the section discusses state and national level cost extrapolations, and modifications to the school district cost estimating procedure for extrapolation purposes.

(1) Data Sources

Estimates presented in Chapters II and III formed the basis for the estimation of the total costs of voluntary asbestos control actions. Chapter II presented unit cost estimates for each corrective action by state; and Chapter III furnished estimates of the number of school districts for which each control action is recommended and the severity of the problem (in terms of square feet of asbestos material to be controlled). The combination of these two data sources resulted in total cost estimates.

Although the estimates presented in Chapters II and III provided the most essential information for estimating total costs of the voluntary control actions, several intermediate steps were necessary before the actual total cost estimates could be developed. These intermediate steps are discussed in the following section.

(2) Adjustments To Unit Cost Estimates

Unit cost estimates were compiled in Chapter III for states within EPA Regions. It was, therefore, necessary to convert state unit cost estimates to cluster level figures. This process involved identifying individual states and the number of these states in each of the twenty clusters of our sample. Within a cluster, each state's unit cost estimate (from Tables 1 to 12) was weighted by the relative frequency of occurrence of the state (i.e., the number of times a sample school district from a given state appeared in the cluster, divided by the total number of school districts in the cluster). The weighted cost estimates from each state were then totaled to produce a weighted average cost estimate for each cluster. This computation was done for each control action in the clusters. These unit cost estimates for control action in each cluster are displayed in Table 16.

In developing weighted unit cost averages, it was sometimes necessary to use EPA regional or national unit cost averages where state data did not exist. In these cases the general rule followed was that the corresponding EPA regional averages were used. If EPA regional average did not exist, the national average for the control action was used.

The cluster unit costs are limited, because they do not represent each cluster exclusively. By using state average cost estimates for a control action, a cluster's unit cost estimate is comprised of cost estimate for work done in all school districts by a contractor. This is regardless of whether the work done by a contractor is for a school district which belongs to a particular cluster or not. Ideally, contractors' cost estimates

TABLE 16

Unit Cost for Voluntary Corrective Action Per Cluster

CORRECTIVE ACTION CLUSTER	INSPECTION PER SCHOOL	BULK TESTING			ENCAPSULATION PER FT.^{2} OF ASBESTOS	REMOVAL PER FT.^{2} OF ASBESTOS	DISPOSAL PER FT.^{2} ASBESTOS	AIR QUANTIFICATION		
		PETROGRAPHIC MICROSCOPY PER SAMPLE	ELECTRON MICROSCOPY PER SAMPLE	X-RAY DIFFRACTION PER SAMPLE				AIR MONITORING (SAMPLING) PER HOUR	LAB COST - ELECTRON MICRO-SCOPY PER SAMPLE	LAB COST - OPTICAL MICROSCOPY PER SAMPLE
1	19.31	44.32	181.84	67.55	2.08	5.06	.43	33.22	230.01	34.09
2	12.13	78.58	114.16	96.17	2.19	5.76	.16	39.17	118.26	81.22
3	76.22	36.01	194.09	64.55	2.93	8.10	.68	38.80	190.33	31.48
4	12.75	38.40	164.94	71.25	2.94	6.94	.60	29.99	213.68	35.55
5	15.56	99.92	120.14	92.30	1.86	5.26	.11	33.78	126.92	96.17
6	9.57	72.09	108.33	87.08	1.96	1.96	.11	34.10	143.75	93.18
7	95.09	34.53	195.68	65.00	3.26	9.50	.84	40.39	185.63	34.76
8	16.76	40.34	174.03	73.32	1.96	4.16	.33	48.73	257.57	32.61
9	19.25	73.61	108.33	85.10	2.10	4.87	.09	34.10	117.19	77.95
10	23.65	55.43	160.47	79.80	2.78	7.57	.44	35.54	187.31	44.97
11	69.68	36.47	199.40	64.00	2.84	8.05	.68	38.70	195.05	31.02
12	12.80	72.60	108.33	86.42	2.01	4.91	.10	34.10	134.90	88.10
13	20.18	86.55	129.16	117.88	2.47	7.20	.15	62.36	100.52	79.01
14	50.90	57.58	204.87	64.25	2.71	7.07	.56	37.42	204.22	30.96
15	11.28	42.50	140.00	95.00	2.12	5.00	.07	30.00	100.00	56.33
16	25.61	43.00	169.23	65.00	1.80	3.50	.15	33.25	189.43	22.00
17	18.10	43.31	170.85	63.17	1.85	4.79	.36	33.18	221.36	31.12
18	20.50	48.39	191.12	61.37	1.66	4.09	.35	35.39	244.45	30.79
19	16.14	38.06	184.87	65.00	2.65	7.00	.56	37.63	187.22	29.45
20	16.84	40.84	158.88	67.64	2.66	5.91	.60	30.93	495.62	40.09

should be differentiated by clusters within states, but this approach would require more extensive surveys than were possible during this study.

Cluster unit cost estimates, at this point, were not standardized. That is, the control action cost estimates were not always based on the same units. For example, inspection cost estimates were given on a per school basis while bulk testing cost estimates were given per sample tested. It was necessary to standardize these varying units to a common standard unit.

The standard unit selected for control activity cost was the affected school district. [*] Table 17 provides a summary of the standardization methodology used for each control action. In Table 17, the cluster unit costs for each control action was adjusted to the school district scale by multiplying it by an indicator of the amount of affected area in a school district. These indicators of affected area included the average number of affected schools per school district, the average square footage of asbestos per school district or some variation of these amounts based on hours of sampling, number of samples, and square footage standards for each test. The result of the standardization process, is a set of affected school district unit cost estimates. Affected school district unit cost estimates are represented by AC_{ij}, where i designates a cluster and j a corrective activity. Table 18 exhibits affected school district unit cost estimates by cluster.

Each affected school district unit cost estimate assumes that all of a school district's asbestos will be the subject of

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[*] Affected school districts are those which require one or more asbestos control action based on the asbestos exposure assessment algorithm.

TABLE 17

Standardization of Cluster Cost to Affected School District Costs

ASBESTOS CORRECTIVE ACTION	CLUSTER UNIT COST	ADJUSTMENTS TO CLUSTER UNIT COSTS			AFFECTED SCHOOL DISTRICT UNIT COSTS (AC_{ij})
Inspection	Cost of inspection per school	Cost of inspection/sch.	X	Average number of affected[1] schools/school district in a given cluster i	Cost of inspecting all affected schools in a school district in a given cluster
Bulk Testing:					
Petrographic test	Cost of one petrographic bulk test	Cost of one petrographic bulk test	X	Average square footage[1] of asbestos per school district in a given cluster i ——— 5000[2]	Cost of petrographic bulk testing in all affected schools in a school district in a given cluster
X-Ray Diffraction	Cost of one X-Ray Diffraction bulk test	Cost of one X-Ray X-Ray diffraction bulk test	X	Average square footage[1] of asbestos per school district in a given cluster i ——— 5000[2]	Cost of X-Ray diffraction bulk testing in all affected schools in a in a school district in a given cluster
Electron Microscopy	Cost of one Electron Microscopy bulk test	Cost of one Electron Microscopy bulk test	X	Average square footage[1] of asbestos per school district in a given cluster i ——— 5000[2]	Cost of Electron Microscopy bulk testing in all affected schools in a given cluster
Encapsulation	Cost of encapsulation per square foot of asbestos	Cost of one Encapsulation per square foot of asbestos	X	Average square footage of asbestos per affected school school districts in a given cluster i	Cost of encapsulating all affected schools in a school district in a given cluster i
Removal	Cost of removal per square foot of asbestos	Cost of one removal per square foot of asbestos foot of asbestos	X	Average square footage of asbestos per affected school district in a given cluster i	Cost of removing asbestos from all affected schools in a school district in a given cluster i
Disposal	Cost of disposal per square foot of asbestos	Cost of disposal per square foot of asbestos	X	Average square footage of per affected school district in a given cluster i	Cost of disposing of asbestos from all affected schools in a school district in a given cluster i
Air Quantification Air Monitoring	Cost per hour of Air monitoring	Cost per hour of 16 hrs.[3] Air monitoring	X	Average number of affected schools per affected school districts in a given cluster i	Cost of air sampling in all affected school in a school district in a given cluster i
Lab-optical Microscopy	Lab cost per sample of optical microscopy test	Lab cost per sample of optical microscopy test	X	5[4] Spl. Average number of affected schools per affected school district in a given cluster i	Cost of optical lab test in a school district in a given cluster i
Lab-Electron Microscopy	Lab cost per sample of electron micros-test	Lab cost per sample of electron microscopy test	X	5 Spl. Average number of affected schools per affected school district in a given cluster i	Costs of electron lab test in all affected schools in a school in a school district in a given cluster i

[1] Source - Arthur Young & Company School Districts Sample. See Appendix A.

[2] One bulk test per 5000 square feet of asbestos is based on specification provided in "Asbestos Containing Materials in School Buildings: A Guidance Document". Part 1 (Washington, D.C.: EPA-OTS, March 1979), p. 10.

[3] Based on NIOSH: "Asbestos Fibers in Air: Analytical Method" (Method No. P&CAM239, 3/30/77) which states that "If one have very little idea of airborne fiber and particulate levels, the best procedure is to take several long samples (as one 8-hour or two consecutive 4-hour samples) in conjunction with several short samples (as four consecutive 2-hour or eight consecutive 1-hour samples)". Any permutation of test combinations would equal 16 total sample hours.

[4] Five samples = one 8-hour sample plus four 2-hour samples. See footnote No. 3.

TABLE 18

AFFECTED SCHOOL DISTRICT UNIT COSTS (AC_{ij})

CORRECTIVE ACTION / CLUSTER	INSPECTION PER SCHOOL	BULK TESTING			ENCAPSULATION PER FT.^{2} ASBESTOS	REMOVAL PER FT.^{2} ASBESTOS	DISPOSAL PER FT.^{2} OF ASBESTOS	AIR QUANTIFICATION		
		PETROGRAPHIC MICROSCOPY PER SAMPLE	ELECTRON MICROSCOPY PER SAMPLE	X-RAY DIFFRACTION PER SAMPLE				AIR MONITOR-ING (SAMPLING) PER HOUR	LAB COST - ELECTRON MICROSCOPY PER SAMPLE	LAB COST - OPTICAL MICROSCOPY
1	48.27	558.43	2291.18	851.13	130,555	317,601	26,990	1328.00	2875.13	426.13
2	12.13	220.02	319.65	269.28	30,660	80,640	2,240	1253.44	1182.60	812.20
3	0	0	0	0	0	0	0	0	0	0
4	42.08	39.80	230.92	102.23	21,092	58,109	4,304	1247.58	2777.84	462.15
5	38.90	1189.05	1429.47	1095.42	110,372	313,909	6,527	1251.20	1586.50	1202.13
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	20.11	177.50	765.73	322.92	42,060	91,607	7,267	1013.58	1674.21	211.97
9	19.25	73.61	108.33	85.10	1,680	3,896	72	545.60	585.95	389.75
10	182.11	2616.30	7574.18	3767.13	656,180	,786,793	103,856	4378.53	7211.44	1731.35
11	69.68	36.47	199.40	64.00	852	2415	204	619.20	975.75	155.10
12	16.64	384.78	574.15	457.35	54,899	129,924	2646	818.40	1011.75	660.75
13	40.36	86.55	129.16	117.88	12,350	36,000	750	1035.52	1005.20	790.10
14	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	68.97	381.13	1503.48	558.49	81,779	211,742	15,914	1592.64	3320.40	2116.80
18	41.00	416.16	1643.63	524.99	71,003	174,942	14,971	1245.73	2688.95	340.67
19	0	0	0	0	0	0	0	0	0	0
20	50.52	40.84	158.88	67.64	9,166	20,366	2,068	1484.64	7434.30	601.35

the respective asbestos control activity. Thus, each unit cost estimate does not account for the possibility that only a portion of the asbestos may be removed, while other areas would be encapsulated. In other words, the cost estimates in Table 18 are mutually exclusive of one another and are calculated on the basis of the average amount of total asbestos per school district in each cluster.

2. EXTRAPOLATED COST ESTIMATES

The affected school district unit cost estimates in Table 18 are the base from which school district, state, and national cost estimates are developed. The following sections outline the methods used to develop aggregate cost estimates.

(1) Cost Estimates for School Districts

To calculate average school district cost estimates by cluster, the affected school district unit cost estimates of the previous section must be modified to reflect the actual mix of control activities recommended for a school district.[*] In other words, each AC_{ij} must be weighted by the frequency of the corresponding control action. Mathematically, this is represented as:

$$AC_{ij} \times SDA_{ij} = C_{ij} \qquad (1)$$

In this equation, AC_{ij} is as defined earlier, SDA_{ij} is the proportion of affected school districts in a cluster (j) for which a control action (j) is recommended, and C_{ij} is the cost estimate for a control action (j) for an average affected school district in a cluster (i).

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[*] See Section 1(6), Chapter III, which discusses the process of identifying the mix of corrective activities in all affected school districts and the total number of school districts in a sample cluster.

Equation (1) was applied to each cluster and recommended control activity to estimate average school district cost estimates for control actions. These average school district cost estimates are summarized in Table 19.

The school district cost estimates in Table 19 must be qualified. Because these cost estimates are built from averages, it would be unlikely to find an actual school district which has an identical cost situation as those in Table 19. The school district cost estimates are, however, considered reasonable for estimation purposes.

(2) Aggregate Cost estimates for States

Aggregate state cost estimates for control activities in individual clusters were developed in much the same way as school district cost estimates. Equation (2) below describes the calculation of aggregate state (k) costs for control action (j) by cluster (i).

$$AC_{ij} \text{ X } TSD_{ij} \text{ X } SN_{ik} = SC_{ijk} \qquad (2)$$

In equation (2), AC_{ij} is as defined earlier the affected school district unit cost estimate for a control action (j) in cluster (i). TSD_{ij} is the proportion of school districts in cluster (i) for which control activity (j) is recommended, and SN_{ik} is the total number of school districts from state (k) in cluster (i). SN_{ik} is not a sample total, but the universe total for each cluster. The product of (AC_{ij}) and (TSD_{ij} X SN_{ik}) is basically the product of the estimated cost per school district for a which a control action (j) is recommended, and C_{ij} is the cost estimate for a control action (j) for an average affected school district in a cluster (i).

Equation (1) was applied to each cluster and recommended control activity to estimate average school district cost estimates for control actions. These average school district cost estimates are summarized in Table 19.

The school district cost estimates in Table 19 must be qualified. Because these cost estimates are built from averages, it would be unlikely to find an actual school district which has an identical cost situation as those in Table 19. The school district cost estimates are, however, considered reasonable for estimation purposes.

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In equation (2), AC_{ij} is as defined earlier the affected school district unit cost estimate for a control action (j) in cluster (i). TSD_{ij} is the proportion of school districts in cluster (i) for which control activity (j) is recommended, and SN_{ik} is the total number of school districts from state (k) in cluster (i). SN_{ik} is not a sample total, but the universe total for each cluster. The product of (AC_{ij}) and $(TSD_{ij} \times SN_{ik})$ is basically the product of the estimated cost per school district for a

Cost of Voluntary Corrective Actions by School District

CORRECTIVE ACTION / CLUSTER		INSPECTION	BULK TESTING			ENCAPSULATION	REMOVAL	DISPOSAL	AIR QUANTIFICATION		
			PETROGRAPHIC MICROSCOPY	ELECTRON MICROSCOPY	X-RAY DIFFRACTION				AIR MONITOR-ING (SAMPLING)	LAB COST - ELECTRON MICROSCOPY	LAB COST - OPTICAL MICROSCOPY
1		31.29	56.	229.	85.	11,097.	0	0	0	0	0
2		6.06	0	0	0	2,554.	11,201	311.	174	164.	113.
3		0	0	0	0	0	0	0	0	0	0
4		18.14	0	0	0	67.	121.	1627.	35.	78.	13.
5		9.00	0	0	0	9,006.	15,287	318.	66.	77.	59.
6		0	0	0	0	0	0	0	0	0	0
7		0	0	0	0	0	0	0	0	0	0
8		11.91	0	0	0	7,710.	0	0	0	0	0
9		9.63	0	0	0	0	0	0	0	0	0
10	3	24.89	0	0	0	66,471.	29,839	1734.	73.	120.	29.
	6	8.01	0	0	0	0	0	0	0	0	0
	7	43.58	0	0	0	131,827.	0	0	0	0	0
	9-10	19.50	0	0	0	70,211.	111,675	6491.	274.	451.	108.
11		44.83	0	0	0	85.	0	0	0	0	0
12		5.55	0	0	0	3,047.	7211.	149.	45.	56.	37.
13		6.93	0	0	0	0	1998.	42.	57.	56.	44.
14		0	0	0	0	0	0	0	0	0	0
15		0	0	0	0	0	0	0	0	0	0
16		0	0	0	0	0	0	0	0	0	0
17		20.74	0	0	0	2,707.	9528.	716.	72.	149.	95.
18		17.56	0	0	0	5,915.	7295.	624.	52.	112.	14.
19		0	16.	68.	27.	0	0	0	0	0	0
20		22.97	19.	72.	31.	0	0	0	0	0	0

TABLE 19

control action and the number of school districts in a state for which that control action is recommended. A table for each cluster, listing states and their estimated control action costs is presented in Appendix B. Table 20 below, summarizes the individual tables by giving state total control activity cost estimates aggregated over all clusters.

Of note in equation (2) is the replacement of SDA_{ij} with TSD_{ij} as a control action multiplier. For state cost estimates, this figure is the proportion of all schools, as opposed to the proportion of affected schools for school district cost estimates. The reason for using different proportions is that for school districts no extrapolation was necessary. The emphasis at the school district level is on what control action is recommended for how much of an average school district's asbestos affected area. Whereas, with state and national aggregate cost estimates, an extrapolation is necessary. Here, the intent was to identify a multiplier from the sample points for which state and national data were available.

(3) Aggregate Cost Estimates for the Nation

Aggregate national costs were developed in an identical manner to total state costs. The only difference between the methods, is that for national cost estimates the total number of school districts in a cluster for the nation, N_i, replaced SN_{ik}. National cost estimates, NC_{ij}, for a control action (j) in a cluster (i) are represented by:

$$AC_{ij} \times TSD_{ij} \times N_i = NC_{ij} \quad (3)$$

Aggregate national cost estimates for each voluntary control activity are presented in Table 21. The bottom row in Table 21 represents the total national cost estimate for individual control actions aggregated over all clusters.

TABLE 20

Summary
Cost of Voluntary Corrective Actions by State

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optional Microscopy
MI	546	4,756	3,760	15,550	5,736	1,568,899	606,806	46,180	8,458	17,996	800
MN	433	3,613	5,301	21,917	8,087	1,464,010	33,991	12,467	1,311	2,786	1,195
MS	154	1,186	1,032	4,463	1,575	247,110	57,235	4,363	881	1,940	428
MO	524	3,077	0	0	0	1,115,541	1,354,011	36,039	19,726	18,832	13,126
MT	581	1,854	0	0	0	386,635	1,602,756	44,145	24,404	23,094	16,232
NB	1,109	2,704	0	0	0	1,044,077	3,131,926	86,616	48,214	45,543	31,313
NV	13	0	0	0	0	0	0	0	0	0	0
NH	155	1,453	1,961	8,185	2,993	547,444	17,569	1,451	144	310	71
NJ	573	4,891	1,513	6,384	2,310	2,320,463	487,473	38,445	3,622	7,649	3,474
NM	87	277	0	0	0	164,260	389,693	9,180	2,939	3,629	2,568
NY	768	6,731	4,747	20,342	7,246	2,774,223	652,505	55,804	4,643	10,030	1,295
NC	137	1,092	412	1,975	630	114,213	115,674	8,773	1,507	3,286	959
ND	321	824	0	0	0	234,034	927,928	25,396	13,825	13,104	9,015
OH	641	2,354	3,306	13,973	5,046	2,090,944	626,313	49,575	4,972	10,570	4,253
OK	616	1,091	0	0	0	372,468	1,420,730	38,311	20,780	19,786	13,679
OR	328	187	38	159	63	242,252	384,566	22,353	828	1,363	327
PA	526	4,632	1,616	6,788	2,466	2,640,800	1,403,567	96,193	7,636	15,505	7,134
RI	37	319	138	568	211	95,559	73,416	5,714	561	1,183	579
SC	95	796	474	2,100	725	149,834	87,619	6,628	941	2,026	783
SD	185	523	0	0	0	192,534	619,538	15,856	7,746	7,586	5,211
TN	138	665	0	0	0	30,054	140,098	10,488	1,574	3,393	1,323
TX	1,058	9,268	0	0	0	656,201	2,311,429	61,251	32,603	31,191	21,755

TABLE 20

Summary
Cost of Voluntary Corrective Actions by State

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optional Microscopy
AL	121	1,210	453	2,996	697	209,636	82,536	7,025	589	1,270	191
AK	35	0	0	0	0	0	0	0	0	0	0
AZ	226	113	38	159	63	161,286	256,377	14,902	552	909	218
AR	371	1,687	0	0	0	232,684	929,682	25,392	13,953	13,230	9,123
CA	1,054	1,096	254	1,067	423	2,248,891	3,589,281	208,625	7,724	12,721	3,054
CO	178	836	0	0	0	149,300	506,681	13,084	6,991	6,744	4,738
CT	147	1,269	803	3,449	1,226	502,627	173,857	14,840	1,239	2,674	367
DE	16	146	91	446	138	24,328	9,284	729	101	219	62
D.C.	1	21	0	0	0	62,768	28,486	1,656	61	101	24
FL	65	530	178	824	272	64,938	79,958	7,161	933	1,994	892
GA	184	1,768	1,444	6,820	2,209	364,150	98,959	7,554	935	2,771	858
HI	1	0	0	0	0	0	0	0	0	0	0
ID	112	22	0	0	0	79,982	128,189	7,451	276	454	109
IL	946	5,521	7,388	30,353	11,271	3,262,903	472,905	36,614	3,720	7,853	3,859
IN	291	2,286	1,684	7,026	2,569	685,962	252,603	19,152	2,283	4,852	2,315
IA	445	1,932	0	0	0	1,421,501	1,307,658	34,511	18,028	17,337	11,978
KS	303	1,514	0	0	0	711,718	880,096	23,133	11,837	11,379	7,880
KY	179	1,651	1,413	6,408	2,159	378,047	91,930	7,117	967	2,088	699
LA	66	423	0	0	0	251,796	529,254	9,512	2,537	2,834	2,145
ME	278	2,727	4,339	18,099	6,621	939,170	12,596	1,078	90	194	24
MD	24	203	2	45	3	74,082	69,099	4,734	463	960	390
MA	356	2,752	2,459	10,514	3,754	1,150,891	351,943	28,375	2,599	5,527	1,984

TABLE 20

Summary
Cost of Voluntary Corrective Actions by State

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optional Microscopy
UT	37	138	0	0	0	78,537	176,502	3,990	1,600	1,645	1,200
VT	247	2,335	4,067	16,715	6,204	828,438	1,743	129	37	83	14
VA	135	1,508	646	2,787	987	883,675	430,729	27,103	1,943	3,845	1,294
WA	299	213	49	204	81	561,085	897,320	52,156	1,931	3,180	764
WV	55	435	140	613	214	227,815	123,692	7,819	740	1,519	416
WI	418	3,430	4,690	19,655	7,157	1,449,323	141,381	11,835	1,098	2,369	463
WY	53	128	0	0	0	86,509	219,724	5,329	2,230	2,231	1,557

Cost of Voluntary Corrective Actions for the Nation

Corrective Action / Cluster		Inspection	BULK TESTING			Encapsulation	Removal	Disposal	AIR QUANTIFICATION		
			Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction				Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
1		30425.	53752.	326418.	81926.	10945078.	0	0	0	0	0
2		7333.	0	0	0	3136518.	13499136.	374976.	209826.	197667.	135962.
3		0	0	0	0	0	0	0	0	0	0
4		4398.	0	0	0	14132.	389330.	28837.	8359.	18612.	3096.
5		1281.	0	0	0	1285613.	2179784.	45323.	9383.	11017.	8348.
6		0	0	0	0	0	0	0	0	0	0
7		0	0	0	0	0	0	0	0	0	0
8		14634.	0	0	0	9475613.	0	0	0	0	0
9		935.	0	0	0	0	0	0	0	0	0
10	3	799.	0	0	0	10733297.	4871168.	283134.	10482.	17264.	4145.
	6	249.	0	0	0	0	0	0	0	0	0
	7	750.	0	0	0	25683247.	0	0	0	0	0
	9-10	809.	0	0	0	13672177.	21920254.	1274101.	47170.	77689.	18652.
11		800.	0	0	0	15379.	0	0	0	0	0
12		284.	0	0	0	156792.	371063.	7557.	2337.	2890.	1887.
13		812.	0	0	0	0	235872.	4914.	6785.	6586.	5177.
14		0	0	0	0	0	0	0	0	0	0
15		0	0	0	0	0	0	0	0	0	0
16		0	0	0	0	0	0	0	0	0	0
17		7793.	0	0	0	916415.	3285389.	246922.	24711.	51519.	32844.
18		5074.	0	0	0	1710036.	2106652.	180281.	15001.	32380.	4102.
19		0	375.	1586.	630.	0	0	0	0	0	0
20		4266.	343.	1336.	569.	0	0	0	0	0	0
		80642.	54470.	329340.	83125.	77744279.	48858648.	2446045.	334054.	415624.	214213.

NOTE: Total National Costs = Sum of all corrective activities and using the least cost methods
for bulk testing (petrographic microscopy) and air sample analysis
(optical Microscopy)

= $(80,642 + 54,470 + 77,744,279 + 48,858,648 + 2,446,045 + 334,054 + 214,213)

= $129.7 Million

Total national cost estimates for each voluntary control action (inspection, petrographic bulk testing, encapsulation, removal, disposal, air sampling, and optical microscropy lab tests), when added, provides a grand total national cost estimates for voluntary asbestos control action of $129.7 million. This figure represents the cost estimate to local school districts if all of the indicated control actions were undertaken. This figure would obviously be different if different choices of control actions were eventually made. Of note is the fact that the least expensive corrective actions were not chosen in all cases. Also of note is that the above total national cost is based on the least expensive (and most available) methods of bulk testing and air quantification. Any change to alternative methods of bulk test and air quantification will increase these total cost estimates.

3. IMPACTS

In addition to the direct costs of the voluntary control activities, other impacts are anticipated. These impacts fall into three categories: (1) negative community impacts, (2) financial impacts, and (3) positive community impacts. These impacts are expected to be most severe for school districts, and are, therefore, analyzed at that level. This section reviews the nature of these three impact areas, and potential ways to lessen them through various forms of funding and assistance.

(1) Negative Community Impacts

Six areas of negative community impacts were identified. These include:

- Students temporarily displaced to other classrooms whether in the same building or another while asbestos-related work takes place

- Change in class size due to student displacements

- Change in student/teacher ratio due to job loss or student displacement

- Temporary or permanent school closings due to the severity of the asbestos problem

- Job loss due to school closings.

Information on negative community impacts was collected from school districts in the study sample. As discussed earlier, the school district administrators were asked by letter if they could estimate the above negative impacts. In their letters, they were asked to coordinate their answers to the responses of their maintenance personnel (regarding the amount of possible corrective action undertaken in their school districts).

Only a limited number of respondents addressed the negative impacts question. Those who did respond all felt that there would be no adverse community impacts of the types listed above. Even those schools that appeared to have potentially significant asbestos problems felt that there would be no negative community impacts.

Many of the respondents stated that the reason for the lack of negative impacts was that school districts would not need to perform any voluntary corrective activities during school hours. School districts, unlike other organizations and businesses, have extended summer and holiday breaks during which to perform corrective maintenance activities. This would not require them to interrupt normal operations.

As a follow-up to the letters, the twenty most severely impacted school districts in the sample which may have extensive removal or encapsulation situations, were contacted for interviews. In the follow-up telephone interviews, the issue of negative community impacts was investigated further by providing these school districts with our estimates of their potential costs. To simulate a worst case situation, we also imposed a hypothetical time constraint, viz. that asbestos corrective activity may have to be performed immediately.

As a result of the above interviews, some of the respondents' perception of potential negative impacts were altered. Of the twenty school districts contacted, one school indicated to possibility of permanent closure, displacing fifty-two students and with two teachers being furloughed. Seven of the remaining school districts may temporarily close a total of twenty-three buildings. These temporary closings could affect a maximum of 10,408 students. In most cases, no indication of the duration of temporary closings could be determined (though two to three months per building was average for two of the three respondents). In no cases were the administrators able to estimate changes in the student/teacher ratios or changes in class size. Once again, it must be noted that these negative impacts were only seen as alternatives in light of having to perform any voluntary corrective actions immediately. If this condition did not exist some of these negative impacts may not have been surfaced. It is interesting to note that twelve of the twenty school districts contacted foresaw no negative impacts even with this constraint imposed. These school districts stated that the work was in building areas such as gymnasiums or special activity rooms which could be closed temporarily without displacing students.

Costs were a serious problem in only one case -- the potential closing identified above. Seventeen of the other school administrators stated that the money could be raised from local budgets (primarily capital as opposed to operating budgets). The remaining two school districts, (in New Mexico), are receiving funding for removal from the state government.[*/] The school districts which would finance corrective activities out of their local budgets, all stated that it would result in a corresponding decrease in some other already budgeted maintenance item. None of the school districts felt that they would forego correcting their asbestos problems if outside funding was not made available, although in some cases it would not be corrected as soon.

In summary, the possible negative community impacts are anticipated to be few and rare in occurrence. Although the response rate was not as great as that for the impacts estimated using the EPA algorithm, a consistent pattern was exhibited in those responses that were received. The trend of these responses suggests that the negative community impacts will be minimal.

(2) Financial Impacts on School Districts

The above twenty relatively severely impacted school districts were analyzed regarding the budget impacts of their voluntary asbestos corrective actions.

The school districts' 1978-79 total, operating, and capital expenditures were analyzed to determine how much of a financial burden the voluntary correction of an asbestos problem will present. The voluntary correction costs for each school district were estimated on the basis of their specific asbestos square footage amounts and their specific responses to the "Exposure Assessment Algorithm". The unit cost estimates which were used to estimate total costs were those presented in Chapter II for

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[*/] See section on State Financial Mechanisms for a discussion of New Mexico's assistance program.

the state in which the school district resides. State costs were able to be used in these cases because of the limited number being estimated as opposed to developing extrapolations, where cluster unit costs were used. It was reasoned that state unit costs would provide more accurate estimates for financial comparison.

These cost estimates were then compared to expenditure estimates for the same school districts.[*] Three categories of school district expenditures were compared to the asbestos voluntary control cost estimates; total expenditures, operating expenditures, and capital expenditures. The results of this comparison are presented in Table 22.

The results in Table 22 are, as mentioned, for the school districts in the samples which have the most severe asbestos problems. In sixteen of the twenty cases, removal is recommended for some or all of the asbestos. In the remaining four school districts, extensive encapsulation is recommended.

Of interest are the large percentages of voluntary/corrective cost estimates to total capital expenditures (the range being from 0.09% to 158.62% of total annual capital expenditures). In some school districts the cost of voluntarily correcting the asbestos problems will far exceed the estimated total annual capital expenditure amount. These patterns are of

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[*] 1978-79 expenditures were estimated from 1977-78 total expenditures per student. This figure was extrapolated to 1978-79 on the basis of that school year's number of students. Estimated 1978-79 total expenditures were then broken down into operating and capital expenditures by using a 92% and 8% distribution formulas. These distributions are based on average distribution for the school districts in 1972 and 1977.

TABLE 22

ASBESTOS CONTROL COST AS A PERCENTAGE OF TOTAL EXPENDITURES

Cluster	Total Asbestos Control Costs	Total Expenditures 1978-79	Total Asbestos Corrective Costs As a Percentage of Total Expenditures	Total Operating Expenditures 1978-79	Total Asbestos Corrective Costs As a Percentage of Total Operating Exp.	Total Capital Expenditures 1978-79	Total Asbestos Corrective Costs As a Percentage of Total Capital Exp.
1)	$ 267,113	$62,724,115	.43%	$57,706,185	.46%	$ 5,017,930	5.32%
2)	1,492,208	23,602,188	6.32	21,714,012	6.87	1,888,176	79.30
3)	515,252	4,586,990	11.23	4,220,031	12.20	366,959	140.41
4)	26,212	21,283,972	.12	19,581,254	.13	1,702,718	1.54
5)	86,192	18,057,074	.48	16,612,508	.52	1,444,566	5.97
6)	38,524	7,526,216	.51	6,924,119	.56	602,097	6.40
7)	7,632	22,190,530	.03	20,415,287	.04	1,775,243	.42
8)	128,212**	97,252,693	.13	89,472,477	.14	7,780,216	1.65
9)	310,601	14,401,800	2.16	13,249,656	2.35	1,152,144	27.00
10)	138,222	3,173,078	4.35	2,919,232	4.73	253,846	54.33
11)	51,412	,493,680	10.32	454,186	11.23	39,494	130.76
12)	91,732	,721,875	12.74	664,125	13.86	57,750	158.62
13)	1,831,333	22,981,480	7.97	21,142,961	8.66	1,838,519	99.56
14)	157,466	7,385,952	2.13	6,795,076	2.32	590,876	26.73
15)	52,357	4,231,720	1.23	3,893,182	1.34	338,538	15.34
16)	1,433,865	31,750,779	4.52	29,210,716	4.91	2,540,063	56.46
17)	1,072*	15,485,312	.01	14,246,487	.01	1,238,825	.09
18)	177,204	2,877,645	6.16	2,647,433	6.69	230,212	76.97
19)	97,501	4,687,161	2.09	4,312,188	2.27	374,973	26.13
20)	34,840	8,372,653	.42	7,702,841	.45	669,812	5.20

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*This school district's costs estimate is based on the percentage of schools affected to total schools in the district times the average cluster costs for corrective actions.

**This does not include removal activities presently being completed in this School District.

concern, given the response of the majority of school administrators from this group who, when interviewed, stated that their most likely source of funding for correcting asbestos problems is the capital budget. It is also notable that, in terms of flexibility, the capital budget is relatively inflexible, especially for larger dollar amounts which may require as much as a referendum.

(3) Positive Community Impacts

Positive community impacts include the number of students and teachers removed from the risk of asbestos exposure, and the number of jobs that may be created in the asbestos correction industry if the voluntary control activities are undertaken. This section estimates these impacts:

- Students/Teachers Removed from Risk

  The voluntary control activities, if undertaken, could result in removing a number of students and teachers from the potential risk of asbestos exposure. The earlier estimate of the number of students affected by the proposed regulation (see Exhibit 6), is the number of students removed from potential risk. This estimate was 4,032,508 students nationwide. The number of teachers removed from potential risk of asbestos exposure is estimated to be 201,625.

  The estimate of the number of teachers removed from risk is based on the fall 1978 national student/teacher ratio for primary and secondary public schools.[*/] A student/teacher ratio of .05 was applied to the over 4 million students potentially removed from risk.

[*/] Source: Digest of Education Statistics 1979, published by the National Center for Education Statistics.

- Jobs Created

A second positive affect is the creation of jobs in the asbestos control and testing industry. In Section 2(3) above, it was estimated that it may cost $129.7 million to voluntarily correct the nation's asbestos problems in public primary and secondary schools. This amount does not truly represent the actual number of man-hours created. To better estimate jobs created, it is necessary to subtract non-labor cost which may be included in the totals. The estimate for encapsulation costs was reduced by twenty-five percent. The percentage is based on New York City estimates of non-labor costs associated with encapsulation. The coverage rate of $30.00 per hour for bulk testing and all air quantification testing and monitoring were reduced by 130 percent. This percentage is an estimate by Tracor-Jitco, Inc. based on their experience with testing. The national cost estimates for inspection, removal, and disposal are unaffected because they represent only labor costs.

By netting out these non-labor costs, the total national labor cost estimates for all possible corrective actions is $109.9 million. A straight labor rate of $9.79 per hour, which is the national average for special trades construction workers (BLS, Employment and Earnings: Sept. 1979), for encapsulation, removal, disposal, and inspection activities; and a straight labor rate of $10.50 per hour (Tracor-Jitco, Inc. estimates) for air quantification and bulk testing by laboratory analyst was applied to the estimated total national labor cost. The resulting man-hours equivalent at this rate is 12,246,194 or 5888 man-years (based on 2080 hours per year).

The man-years would not necessarily result in that number of new jobs. This is because the industry as it now exists would be able to absorb a portion of this new demand. A more realistic number of new jobs should be somewhat lower.

4. FINANCIAL MECHANISMS AVAILABLE TO SCHOOL DISTRICTS

Local school districts are able to draw on three sources of funding. These sources are: 1) local taxes and charges, 2) indebtedness and debt transactions, 3) intergovernmental transfers or revenues. All of these are possible sources that could be used by school districts to perform various recommended asbestos corrective actions.

- Local Taxes and Charges

  Local taxes and user charges are the largest source of school district revenues. In 1972, taxes and charges accounted for 54.8 percent of school district's total revenues, nationally. Making-up taxes and charges are property taxes and other taxes (48.1%), and current charges, sales, interest earned, and miscellaneous revenues (6.7%).*/ Local taxes and charges are used primarily in the school district's annual operating budget.

- Intergovernmental Revenues

  Intergovernmental revenues from the Federal, state, and other local governments account for 45.3 percent of local school district's revenue sources. These revenues are usually distributed among the operating and capital budgets, depending upon whether or not the intergovernmental revenues are "earmarked" for a specific use. The largest percentage of such transfers are from state governments (93.4%), with the remainder coming from the Federal government and other local governments.

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*/Source: 1972 Census of Governments: Finances of School Districts.

- Indebtedness and Debt Transactions

  Long-term indebtedness, usually through the floating of bond issues on the public market, is the third source of revenues available to local school districts. This source is primarily reserved for large scale capital improvement and building projects. Very often a portion of the fund from a bond sale will be set aside to finance equipment replacement and physical plant improvements of minor nature.

  Debt service on outstanding notes and issues are not usually financed from existing bond issues, but from the general operating budget. Funds from the sale of bonds or other long-term indebtedness are apportioned yearly through a capital improvements budget approved by the local school board. A bond issue most often requires a referendum vote before a sale can be made.

The local capital improvement budget and operating budget are the only direct means by which a local school district is able to finance such special projects as asbestos control actions. Generally, school districts would have to either expand one of these budgets or redistribute funds within them. To expand these budgets, school districts have increasingly been seeking greater intergovernmental transfers. The following two sections review the availability of state and Federal assistance for local asbestos corrective actions.

- State Assistance for Local School District's Asbestos Costs

  Intergovernmental revenues from state governments provide a substantial portion of the total amount of such transfers to local school districts. Each state is in some way unique, not only in terms of their approach to assisting local school districts, but specifically on how they consider their funds' availability for asbestos corrective costs. It is not possible to provide a set of state funding sources which are applicable to all states. For this reason each state is addressed separately in this section.

The following list summarizes state financial aid available to local school districts for asbestos corrective activities. These summaries were obtained through telephone interviews with State Departments of Education.

Alabama - No state program for asbestos control. There is a minimum amount of state funding for capital outlays which amounts to $64.87 per earned teacher unit. (The average school system has 150-300 teachers); these funds could be appropriated for asbestos corrective action.

Alaska - No state funds currently earmarked specifically for asbestos corrective action. State does provide both capital and operating funds for the local school district. It is possible that asbestos corrective funds could come from this source, depending on the outcome of State legislation.

California - No state funds are presently available for asbestos corrective action. A bill will be introduced to the state legislature which would provide matching funds to the school districts for asbestos corrective action to be undertaken. Funding would be retroactive to January 1, 1977. The bill will provide a 50/50 match between the state and local school district(s). If the Federal government provides any funding, the match will be adjusted to reflect a 50% Federal, 25% State, and 25% local distribution. Approximately $3-5 million is proposed to be earmarked for asbestos corrective actions in the bill.

Connecticut - State bond funds are available to local school districts for asbestos corrective action. Schools receive 30-80% State aid under a reimbursement system.

Delaware - General Operating Fund: This fund is available to local school districts for renovation of existing facilities as well as construction of new facilities. Depending upon the amount of outlay, asbestos removal could be funded through the operating budget. Otherwise removal would be treated as a capital improvement and funded through state bonds. The state would pay up to sixty percent of the improvements. Bonds would normally be retired at the end of 20 years. In the event of a sufficient surplus in the general operating fund, no bonds would be required and general funding would be used. If the general fund is used, such a one-time removal would be treated separately from recurring projects.

Hawaii - Hawaii schools are set up in one district. The state legislature is considering $5.4 million in general obligation bonds for asbestos corrective actions.

Illinois - There are no state funds for asbestos corrective action. However, there is a Health and Life Safety Tax which the local school districts can levy to raise funds to comply with health and safety regulations.

Kentucky - There is no specific state funding program for asbestos control in local school districts, however the state does distribute capital outlays to the local school districts for maintenance and operations. Capital outlay funds could be used for asbestos corrective action but many of the schools have already depleted this source of funds.

Maine - There is no specific state funding program for asbestos corrective actions, however the state subsidizes local school districts' operating budgets which could fund asbestos control to some extent. Asbestos corrective action would not be funded through the capital improvements and construction funds which are bonded at the local level and subsidized by the state.

Massachusetts - State legislature appropriated $2 million for asbestos corrective action to be used for recommendations made by the State Asbestos Commission. This is a reimbursement program of which 25% of the cost of a bid is allocated and the rest is determined by a sliding scale of 50-75% depending on the school category (which varies from wealthy to poor districts).

Appropriation Requirements:

1. Work must be contracted (but not necessarily performed) before July 1980.

2. All work must be certified by the Massachusetts Asbestos Commission.

3. Maintain cost control over work and materials.

(The Massachusetts Asbestos Commission is appointed by the legislature and is within the State Division of Occupational Health)

Nebraska - No state funds are presently available for asbestos control. Some legislation is being introduced to fund laboratory testing activities.

New Hampshire - Construction and Building Aid: This state fund makes payments of from 30 percent to 55 percent of the principal per year for capital expenditures which are used to change a structure or capacity of a building. This fund was used in the past by local school districts for structural changes to accommodate increased student enrollments. Currently, this aid package is also used for renovation and alteration but not maintenance purposes. Renovation purposes could, in certain unspecified situations, possibly include asbestos corrective actions and replacement activities.

New Jersey - General Fund: This fund is available to local school districts to remodel old and build new facilities. Depending upon the wealth of the county, the state may fund, through a bond issue, a portion of between ten and fifty percent of such projects. Funds designated for one remodeling program may be used for other related programs, such as removal of friable containing materials. Any substantial capital outlay is reimbursed by the state the following year. Reimbursement is on the amount originally agreed upon regardless of the use of funds.

New Mexico - There is no appropriation by the state legislature for funding assistance for asbestos corrective actions. The state's Department of Finance and Administration, though, has transferred funds from other sources to help fund individual school districts with their removal problems. This is a one-time arrangement which will finance asbestos removal at $2.17 per square foot (of asbestos) in Dora, Reserve, Quemado, and Ariams school districts. These are the only districts receiving such funds due to the immediacy of their asbestos problems and their low tax-base capacity. The funds are to be used only for removal of asbestos. Replacement of ceilings, insulation, etc.. will be paid for out of local school district budgets.

New York - No specific state funds are set aside for asbestos control, but local school districts could draw from the "typical building construction aid" fund provided by the state. This aid varies from 0% (wealthy districts) to 95% (poor districts) depending on need (average 49%). Legislature is currently investigating the impact of asbestos containment and the possibility of state aid.

Rhode Island - Reimbursement of Renovations: The state reimburses local school districts after a renovation problem has been corrected. The state health code identifies asbestos as a potential health problem and thereby could be interpreted as requiring schools with asbestos to be renovated. Renovations are guaranteed by the state up to a minimum of thirty percent reimbursement.

South Carolina - No state funds specifically for asbestos corrective actions. The state does provide funds to local district on a per person basis. For the last 3-4 years $30/per pupil has been appropriated. Of this amount, only 15-20% is used for capital improvements and construction as a supplemental funding source. This money could be used for asbestos corrective action.

Tennessee - General Fund: Available to local school districts to rebuild old and construct new facilities. The source of funding is dependent upon the amount of outlay. A major outlay for asbestos corrective actions would require a bond issue. Generally, for building and renovation, the state will match funds on an issue to retire at the end of thirty years. Removal of friable materials would be considered a renovation in that construction would replace structures containing asbestos.

Texas - No state funds available for asbestos corrective actions. However, the states provide \$7-8 million yearly in entitlement funds to the school districts. This could be a source of funding for asbestos reconstruction.

Utah - No specific state funding for asbestos corrective action. The state does provide a general building fund of \$13 million for this school year (\$17.5 million proposed for next year). Some of this money is earmarked for critical needs - otherwise monies could be used for asbestos control.

Vermont - The state provides construction aid to the local school districts for meeting standards and regulations of any state agency (i.e., asbestos corrective action). The school districts are reimbursed 30%.

Washington - Capital Construction Fund: This fund is available to local school districts to remodel old and build new facilities. This is a matching grant which at present provides for a fifty percent state and fifty percent local school district formula. These monies can be applied to asbestos corrective actions in very limited instances where water damage or other "Acts of God" result in the need for remodeling a portion of a building which contains friable asbestos.

Wyoming - No specific state funds for asbestos correction, however, there is a State Capital Construction Entitlement Fund which goes only to "foundation programs" (the poor half of the local school districts). This fund provides from a few thousand to \$1 million annually per school district. Conceivably only a small amount would be available for asbestos correction.

States which provide no funds which could be used for asbestos control actions in school districts are the following:

Arkansas
Colorado
District of Columbia
Florida
Georgia
Idaho
Indiana
Iowa
Kansas
Louisiana
Maryland
Michigan
Minnesota
Mississippi
Missouri
Montana
Nevada
North Carolina
North Dakota
Ohio
Oklahoma
Oregon
Pennsylvania
South Dakota
Virginia
West Virginia

• Federal Assistance for Local School Districts' Asbestos Costs

On May 16, 1980, the U.S. Congress passed the Asbestos School Hazard Detection and Control Act of 1980 (PL 96-270). The Act establishes as its primary purpose a Federal grant and loan program to assist local educational agencies in detecting and controlling asbestos hazards. It establishes a direct grant program (effective for two years after the effective date of this Act) to local educational agencies for 50% of the cost of detecting the presence of asbestos in schools. The Act also directs the Secretary of Education to administer a long term loan program for 50% of the costs of containing or removing asbestos materials in schools which pose imminent hazards to school children and employees. The corrective action loan program may be utilized for qualifying projects that were on-going as of January 1, 1976.

The Act authorizes the Secretary to establisn an Asbestos Hazards School Safety Task Force to compile medical, scientific, and technical information on the health hazards of asbestos and the means to identify sample, and test materials suspected of emitting asbestos fibers. The Task Force will distribute this information to State educational agencies, review grant and loan applications submitted to the Secretary for asbestos detection and control programs, review EPA guidelines, and assist the Secretary in promulgating standards and safety procedures.

5. CONCLUSION

The total cost for the voluntary control of asbestos in primary and secondary public schools in the nation is estimated at approximately $129.7 million. This cost is not anticipated to cause extensive negative community impacts. It will, however, provide the equivalent of 5888 additional man-years of work for the asbestos control and testing industry.

The reliability of these estimates are dependent upon the validity of the unit cost estimates and the sample. The statistical validity of the school district sample, as discussed in previous chapters is questionable. Therefore, the inferences and estimates of this chapter may be subject to variation.

V. COST OF PROPOSED IDENTIFICATION AND NOTIFICATION RULE

The costs of EPA's proposed rule requiring school districts to identify and file notification of asbestos containing materials in their building are examined in this chapter. As noted previously in this report, the proposed Identification and Notification Rule mandates, among other requirements, the inspection and bulk testing of materials which are friable and could contain asbestos. The inspection and bulk testing process would be the responsibility of individual school districts.

Earlier chapters of this report have presented cost estimates for school district to conduct inspections and bulk tests. These estimates could be improved for three reasons; one, the unit cost averages used to calculate total costs may have been biased by the presence of extreme sample points or outliers; two, the number of affected schools is based on a sample of school districts which may be unrepresentative in their knowledge of the asbestos "problem", they can be redefined to include only those requirements of the proposed rule. In the remainder of this chapter, these concerns are examined and reestimated cost impacts developed.

1. ADJUSTMENTS TO UNIT COST DATA

The unit cost data estimates for the proposed inspection and bulk testing requirements were initially presented in Tables 1 through 4 in Chapter II of this report. Through subsequent analysis and review it was determined that these unit cost estimates could be improved by eliminating extreme sample points or outliers from the samples. The inclusion of these outliers resulted in high unit cost variances and average unit costs which may not be accurate for estimation purposes. To reduce the variances and estimate more meaningful unit cost averages, Category Two responents (see Chapter II for definition) were telephoned a second time.

The second series of telephone calls concentrated on laboratories which perform bulk sample analysis and air sampling. Although air sampling is not required under the proposed rule, many laboratories perform both activities. To minimize the possibility of having to contact the same persons multiple times in the future, data on both activities were requested at this time. In this section, reestimated unit costs were developed for all three methods of bulk testing and for air sampling activities. However, only total costs for the polarized light microscopy and X-ray diffraction methods of bulk testing have been attributed to the cost of the proposed rule (see Chapter VI). Adjustments to the inspection unit cost were not necessary.

The second telephone contact with laboratory facilities focused on verifying unit cost data previously compiled. Verification was conducted for those laboratories which initially provided extremely high or low unit cost estimates. Also, unit costs, obtained from contractors who used secondary sources and price quotes from other firms, were eliminated from the sample. Category Three respondents (see Chapter II) were not recontacted because of their inability to provide data during the first series of telephone calls.

As a result of the second series of telephone calls, average unit cost estimate changes were made in the following five laboratory analysis areas:

- Polarized Light Microscopy Analysis Costs

- X-Ray Diffraction Analysis Costs
- Electron Miscroscopy Analysis Costs
- Costs of Air Filter Sample Analysis by Optical Microscopy
- Costs of Air Filter sample Analysis by Electron Microscopy

Each of the above five average unit costs are discussed below. Tables showing the final data at the state and EPA region levels of detail are also presented.

(1) Polarized Light Microscopy (PLM) Analysis Costs

In total, seventy-six laboratories provided usable information in this cost category. A national average of $42.59 per sample was calculated with a range of $10.00 to $150.00 per sample (see Table 23).

Unit costs for PLM analyses are often related to the number of samples submitted. Discounts are allowed for larger numbers. For example if more than one sample is submitted, a 10% discount is usually offered by most laboratories. Some laboratories offer as high as 50 percent discounts if more than 100 samples are submitted. Other laboratories set their unit price per sample on a minimum number of samples submitted, for example, four. In all cases, the unit costs provided include labor as well as material costs.

The coefficient of variation (CV) for the nation is 58.79% while that for the regions is 18.58%. The high variation from state-to-state is mainly due to a wide range of values, e.g., $10.00 (North Carolina), $10.00 (Hawaii), $145.00 (Ohio), and $150.00 (Connecticut).

TABLE 23

COSTS PER SAMPLE OF TESTING FRIABLE MATERIALS FOR ASBESTOS BY POLARIZED LIGHT MICROSCOPY

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	$ 95.00 (2)	±77.78	(40.00-150.00)
Maine	a		
Massachusetts	47.60 (5)	±29.60	(28.00-100.00)
New Hampshire	a		
Rhode Island	a		
Vermont	a		
All Region I	61.14 (7)	±46.12	(28.00-150.00)
Region II:			
New Jersey	41.00 (8)	±16.37	(18.00- 75.00)
New York	38.75 (4)	±14.93	(25.00- 60.00)
All Region II	40.25 (12)	±15.25	(18.00- 75.00)
Region III:			
Delaware	50.00 (1)		
Dist. of Columbia	a		
Maryland	40.00 (2)	±14.14	(30.00-50.00)
Pennsylvania	36.00 (3)	± 5.29	(30.00-40.00)
Virginia	37.50 (2)	±17.68	(25.00-50.00)
West Virginia	a		
All Region III	39.12 (8)	±10.16	(25.00-50.00)
Region IV:			
Alabama	a		
Florida	43.00 (5)	±32.52	(20.00-100.00)
Georgia	40.00 (1)		
Kentucky	a		
Mississippi	a		
North Carolina	23.33[b] (3)	±12.58	(10.00- 35.00)
South Carolina	c		
Tennesse	40.00 (1)		
All Region IV	36.50 (10)	±24.27	(10.00-100.00)
Region V:			
Illinois	57.50 (4)	±25.33	(25.00-80.00)
Indiana	50.00 (1)		
Michigan	33.33 (3)	±15.27	(20.00-50.00)
Minnesota	25.00 (2)	0	(25.00-25.00)
Ohio	57.14 (7)	± 42.41	(20.00-145.00)
Wisconsin	27.50 (2)	± 3.53	(25.00-30.00)
All Region V	46.58 (19)	±30.42	(20.00-145.00)
Region VI:			
Arkansas	a		
Louisiana	25.00 (1)		
New Mexico	a		
Oklahoma	a		
Texas	50.00 (4)	±23.80	(25.00- 75.00)
All Region VI	45.00 (5)	±23.45	(25.00- 75.00)
Region VII:			
Iowa	a		
Kansas	a		
Missouri	50.00 (1)		
Nebraska	a		
All Region VII	50.00 (1)		

TABLE 23

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	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado	$ 46.25 (4)	±14.93	(25.00-60.00)
Montana	a		
North Dakota	a		
South Dakota	a		
Utah	37.50 (2)	±17.68	(25.00-50.00)
Wyoming	a		
All Region VIII	43.33 (6)	±14.72	(25.00-60.00)
Region IX:			
Arizona	a		
California	32.00 (5)	± 4.47	(25.00-35.00)
Hawaii	17.50 (2)	±10.61	(10.00-25.00)
Nevada	a		
All Region IX	32.00 (7)	± 4.47	(10.00-35 .00)
Region X:			
Alaska	a		
Idaho	a		
Oregon	a		
Washington	43.00 (1)		
All Region X	43.00 (1)		
All Nation	42.59 (76)	±25.04	(10.00-150.00)

a. No information was obtained from this state.

b. Services provided upon request and without charge to employers within the State by the Consultative Services Section of the State Department of Labor.

c. Department of Health and Environmental Control have agreed to perform a minimum of bulk sample analysis for public schools.

(2) X-Ray Diffraction (XRD) Analysis Costs

Table 24 summarizes the unit costs of testing friable materials for asbestos by X-ray diffraction. A national average of $70.00 per sample was estimated from 52 laboratories. The comparison of the regional average costs per sample indicated that Region VII has the highest cost, $200 (one laboratory) while Region V shows the lowest cost, $54.64 (14 laboratories).

As in PLM analyses, unit costs for XRD are dependent on the number of samples submitted. Discount ranges from 10% to 30% on increasing number of samples. Costs include the cost for labor as well as materials used in the laboratory.

There are significant national (CV = 49.74%) as well as regional variations (CV = 52.87%). These are due to a combination of insufficient sample size and a few extremely high costs. For example, the States of Colorado, Massachusetts, Missouri and New Jersey reported costs per sample greater than $145.00. For Region VII, only one cost estimate was received, i.e., $200.00 per sample.

(3) Electron Microscopy (EM) Analysis Costs

The per sample costs of testing friable materials for asbestos by electron microscopy is presented in Table 25. A total of 20 laboratories provided cost information from which a national average of $188.00 per sample was estimated. The per sample cost ranges from $75 in Colorado to $350 in Illinois.

Unlike PLM and XRD analyses, the number of samples submitted for EM analysis does not necessarily alter the unit costs. Only a few laboratories indicated that discounts would be offered if more than three to five samples were submitted. The reason for a fixed unit cost for EM analyses is that EM is costly, time

TABLE 24

COSTS PER SAMPLE OF TESTING FRIABLE MATERIALS FOR ASBESTOS BY X-RAY DIFFRACTION

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	$ 100.00 (1)		
Maine	a		
Massachusetts	96.67 (3)	± 50.33	(50.00-150.00)
New Hampshire	100.00 (1)		
Rhode Island	a		
Vermont	a		
All Region I	98.00 (5)	± 35.64	(50.00-100.00)
Region II:			
New Jersey	85.00 (6)	± 35.21	(60.00-150.00)
New York	47.50 (2)	± 17.68	(35.00- 60.00)
All Region II	75.62 (8)	± 35.09	(35.00-150.00)
Region III:			
Delaware	a		
Dist. of Columbia	a		
Maryland	52.50 (2)	± 3.53	(50.00- 55.00)
Pennsylvania	80.00 (2)	± 28.28	(60.00-100.00)
Virginia	75.00 (1)		
West Virginia	a		
All Region III	68.00 (5)	± 20.19	(50.00-100.00)
Region IV:			
Alabama	a		
Florida	60.00 (1)		
Georgia	a		
Kentucky	30.00 (1)		
Mississippi	a		
North Carolina	90.00 (1)		
South Carolina	a		
Tennesse	a		
All Region IV	60.00 (3)	± 30.00	(30.00- 90.00)
Region V:			
Illinois	63.33 (3)	± 20.21	(40.00- 75.00)
Indiana	100.00 (1)		
Michigan	45.00 (5)	± 7.07	(35.00- 50.00)
Minnesota	35.00 (2)	0	(35.00- 35.00)
Ohio	60.00 (3)	± 36.05	(30.00-100.00)
Wisconsin	b		
All Region V	54.64 (14)	± 23.57	(30.00-100.00)
Region VI:			
Arkansas	a		
Louisiana	35.00 (1)		
New Mexico	a		
Oklahoma	a		
Texas	75.00 (5)	± 25.00	(50.00-100.00)
All Region VI	68.33 (6)	± 27.69	(35.00-100.00)
Region VII:			
Iowa	a		
Kansas	a		
Missouri	200.00 (1)		
Nebraska	a		
All Region VII	200.00 (1)		

TABLE 24

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado	$ 83.33 (3)	± 57.73	(50.00-150.00)
Montana	a		
North Dakota	a		
South Dakota	a		
Utah	57.50 (2)	± 24.75	(40.00- 75.00)
Wyoming	a		
All Region VIII	73.00 (5)	± 44.94	(40.00-150.00)
Region IX:			
Arizona	a		
California	55.00 (3)	± 8.65	(50.00- 65.00)
Hawaii	60.00 (1)		
Nevada	a		
All Region IX	56.25 (4)	± 7.50	(50.00- 65.00)
Region X:			
Alaska	a		
Idaho	a		
Oregon	a		
Washington	65.00 (1)		
All Region X	65.00 (1)		
All Nation	70.09 (52)	± 34.86	(30.00-200.00)

a. No information was obtained from this state.

TABLE 25

COSTS PER SAMPLE OF TESTING FRIABLE MATERIALS FOR ASBESTOS BY ELECTRON MICROSCOPY

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	a		
Maine	a		
Massachusetts	190.00 (2)	±155.56	(80.00-300.00)
New Hampshire	100.00 (1)		
Rhode Island	a		
Vermont	a		
All Region I	160.00 (3)	±121.65	(80.00-300.00)
Region II:			
New Jersey	300.00 (1)		
New York	b		
All Region II	300.00 (1)		
Region III:			
Delaware	a		
Dist. of Columbia	a		
Maryland	200.00 (2)	± 70.71	(150.00-250.00)
Pennsylvania	a		
Virginia	162.50 (2)	± 53.03	(125.00-200.00)
West Virginia	a		
All Region III	181.25 (4)	± 55.43	(125.00-250.00)
Region IV:			
Alabama	a		
Florida	a		
Georgia	a		
Kentucky	a		
Mississippi	a		
North Carolina	180.00 (1)		
South Carolina	a		
Tennesse	a		
All Region IV	180.00 (1)		
Region V:			
Illinois	325.00 (2)	± 35.35	(300.00-350.00)
Indiana	150.00 (1)		
Michigan	150.00 (1)		
Minnesota	c		
Ohio	a		
Wisconsin	a		
All Region V	237.50 (4)	±103.08	(150.00-350.00)
Region VI:			
Arkansas	a		
Louisiana	a		
New Mexico	a		
Oklahoma	a		
Texas	125.00 (2)	± 35.35	(100.00-150.00)
All Region VI	125.00 (2)	± 35.35	(100.00-150.00)
Region VII:			
Iowa	a		
Kansas	a		
Missouri	200.00 (1)		
Nebraska	a		
All Region VII	200.00 (1)		

TABLE 25

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado	$ 75.00 (1)		
Montana	a		
North Dakota	a		
South Dakota	a		
Utah	100.00 (1)		
Wyoming	a		
All Region VIII	87.50 (2)	± 17.68	(75.00-100.00)
Region IX:			
Arizona	a		
California	300.00 (1)		
Hawaii	200.00 (1)		
Nevada	a		
All Region IX	250.00 (2)	± 70.71	(200.00-300.00)
Region X:			
Alaska	a		
Idaho	a		
Oregon	a		
Washington	a		
All Region X	a		
All Nation	188.00 (20)	± 85.28	(75.00-350.00)

a. No information was obtained from this state.

b. $60.00 per hour is charged by one contractor.

c. Analysis is available, but no cost was provided by contractors.

consuming, and limited in availability. As with the other analyses, each unit cost includes the cost for labor, material, and other expenses which are required to perform the test.

A coefficient of variation of 45.36% represents the variation from state-to-state across the nation, while a cofficient of variation of 34.01% indicates the variation from region to region. These variations are again probably due to insufficient sample size. An important note regarding sample size here is that, since availability of EM analysis is rather limited, the sample size is unavoidably small.

(4) Costs of Air Filter Sample Analysis by Optical Microscopy

The costs of analyses of asbestos air samples by optical microscopy (NIOSH Method) are summarized in Table 26. A national average of $36.80 per sample with a standard deviation of $17.46 was estimated from 89 laboratories.

The unit cost includes the cost of labor and materials. As in other analytical costs, discounts may be allowed depending on the number of samples delivered for analysis.

State-to-state variation was found to be represented by a coefficient of variation of 47.44%. The coefficient of variation among regions is 23.43%. It is difficult to explain the large variations in this case since optical microscopy has become such a standardized test for asbestos air sample analysis.

(5) Cost Of Air Filter Sample Analysis By Electron Microscopy

Table 27 summarizes the costs of analyses of asbestos air samples by electron microscopy. The cost per sample ranges from $80.00 in Massachusetts to $350.00 in Pennsylvania. These costs

TABLE 26

COST PER SAMPLE OF ANALYSES OF ASBESTOS AIR SAMPLE BY OPTICAL MICROSCOPY (NIOSH METHOD)

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	$ 47.50 (4)	± 35.94	(20.00-100.00)
Maine	a		
Massachusetts	48.40 (5)	± 31.31	(22.00-100.00)
New Hampshire	a		
Rhode Island	a		
Vermont	a		
All Region I	48.00 (9)	± 31.22	(20.00-100.00)
Region II:			
New Jersey	36.43 (7)	± 12.15	(15.00- 50.00)
New York	48.33 (3)	± 25.17	(25.00- 75.00)
All Region II	40.00 (10)	± 16.50	(25.00- 75.00)
Region III:			
Delaware	50.00(1)		
Dist. of Columbia	a		
Maryland	42.50 (2)	± 10.61	(35.00- 50.00)
Pennsylvania	31.43 (7)	± 11.80	(15.00- 50.00)
Virginia	37.50 (2)	± 17.68	(25.00- 50.00)
West Virginia	a		
All Region III	35.83 (12)	± 12.40	(15.00- 50.00)
Region IV:			
Alabama	a		
Florida	31.75 (4)	±14.22	(17.00- 50.00)
Georgia	40.00 (1)		
Kentucky	25.00 (1)		
Mississippi	a		
North Carolina	35.00[b] (2)	± 14.14	(25.00- 45.00)
South Carolina	a		
Tennesse	40.00 (1)		
All Region IV	33.56 (9)	± 11.07	(17.00- 50.00)
Region V:			
Illinois	32.00 (5)	± 16.81	(20.00- 60.00)
Indiana	50.00 (1)		
Michigan	17.90 (5)	± 3.47	(12.00- 20.00)
Minnesota	35.00 (2)	± 14.14	(25.00- 45.00)
Ohio	40.17 (6)	± 9.39	(25.00- 50.00)
Wisconsin	26.25 (4)	± 6.29	(20.00- 35.00)
All Region V	31.11 (23)	± 13.12	(12.00- 60.00)
Region VI:			
Arkansas	a		
Louisiana	42.00 (1)		
New Mexico	a		
Oklahoma	a		
Texas	47.50 (4)	± 22.17	(25.00- 75.00)
All Region VI	46.40 (5)	± 19.36	(25.00- 75.00)
Region VII:			
Iowa	25.00 (1)		
Kansas	a		
Missouri	50.00 (1)		
Nebraska	70.00 (1)		
All Region VII	48.33 (3)	± 22.55	(25.00- 70.00)

TABLE 26

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado	$ 45.83 (6)	± 20.59	(20.00- 80.00)
Montana	a		
North Dakota	a		
South Dakota	a		
Utah	37.50 (2)	± 17.68	(25.00- 50.00)
Wyoming	15.00 (1)		
All Region VIII	40.55 (9)	± 20.22	(20.00- 80.00)
Region IX:			
Arizona	a		
California	30.33 (6)	± 10.13	(22.00- 50.00)
Hawaii	25.00 (2)	± 0	(25.00- 25.00)
Nevada	a		
All Region IX	29.00 (8)	± 8.91	(22.00- 50.00)
Region X:			
Alaska	a		
Idaho	a		
Oregon	a		
Washington	22.00 (1)		
All Region X	22.00 (1)		
All Nation	36.80 (99)	±17.46	(12.00-100.00)

a. No information was obtained from this state.

b. "Services provided upon request and without charge to employers within the State by the Consultative Services Section of the State Department of Labor."

TABLE 27

COSTS PER SAMPLE OF ANALYSES OF ASBESTOS AIR SAMPLES BY ELECTRON MICROSCOPY

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region I:			
Connecticut	\$ 266.67^{c} (1)		
Maine	a		
Massachusetts	190.00 (2)	±155.56	(80.00-300.00)
New Hampshire	100.00 (1)		
Rhode Island	a		
Vermont	a		
All Region I	186.67 (4)	±112.74	(80.00-300.00)
Region II:			
New Jersey	283.33 (2)	± 23.57	(266.67^{c}-300.00)
New York	a		
All Region II	283.33 (2)	± 23.57	(266.67^{c}-300.00)
Region III:			
Delaware	a		
Dist. of Columbia	a		
Maryland	272.50^{d} (1)		
Pennsylvania	308.33 (2)	± 58.92	(266.67^{c}-350.00)
Virginia	200.00 (1)		
West Virginia	a		
All Region II~~I~~	272.29 (4)	± 61.36	(200.00-350.00)
Region IV:			
Alabama	a		
Florida	a		
Georgia	a		
Kentucky	a		
Mississippi	a		
North Carolina	a		
South Carolina	a		
Tennesse	a		
All Region IV	a		
Region V:			
Illinois	325.00 (2)	±35.35	(300.00-350.00)
Indiana	100.00 (1)		
Michigan	150.00 (1)		
Minnesota	a		
Ohio	a		
Wisconsin	100.00 (1)		
All Region V	200.00 (5)	±117.26	(100.00-350.00)
Region VI:			
Arkansas	a		
Louisiana	a		
New Mexico	a		
Oklahoma	a		
Texas	125.00 (2)	± 35.35	(100.00-150.00)
All Region VI	125.00 (2)	± 35.35	(100.00-150.00)
Region VII:			
Iowa	a		
Kansas	a		
Missouri	200.00 (1)		
Nebraska	a		
All Region VII	200.00 (1)		

TABLE 27

	Mean (Sample Size)	± 1 Standard Deviation	Range
Region VIII:			
Colorado	$ 75.00 (1)		
Montana	a		
North Dakota	a		
South Dakota	a		
Utah	100.00 (1)		
Wyoming	a		
All Region VIII	87.50 (2)	± 17.68	(75.00-100.00)
Region IX:			
Arizona	a		
California	270.00 (1)		
Hawaii	a		
Nevada	a		
All Region IX	270.00 (1)		
Region X:			
Alaska	a		
Idaho	a		
Oregon	a		
Washington	a		
All Region X	a		
All Nation	204.64 (21)	± 95.67	(80.00-350.00)

a. No information was obtained from this state.

b. $60.00 per hour.

c. $100.00/sample for scanning EM; $300.00/sample for SEM + EDS; $400.00/sample for transmission EM; (100.00 + 300.00 + 400.00) = 266.67/sample.

d. $320.00/sample for Transmission EM; $225.00/sample for Scanning EM; ($320.00 + 225.00) = $272.50/sample.

give a national average of $204.64 with a standard deviation of $95.67. Each unit cost includes labor as well as material costs.

The variation in state means is indicated by a coefficient of variation of 46.75% while the variation among the regions is shown by a coefficient of variation of 35.04%. The large variations are likely due to insufficient sample size.

2. ADJUSTMENT TO THE ESTIMATES OF AFFECTED POPULATION

As noted earlier in this report (see Chapter III), estimates of the number of school districts and public schools which would be affected by the proposed rule were subject to data limitations.

The original sample of school districts was chosen from those districts that had responded to EPA's voluntary survey. Because the original sample was chosen from this base, sample bias may have been introduced in the form of having districts which are knowledgeable of and active in voluntary asbestos control programs. This may or may not be characteristic of the average school district in the universe.

The following sections discuss the methodological steps used to investigate this potential bias. The steps include developing a set of questions and questioning procedures, choosing a non-respondent sample, collecting responses and analyzing the variances between the original survey data and the results of this non-respondent survey. The results of the variance analysis are presented along with a reevaluation of the original estimates of inspection and bulk testing costs for the affected school districts and students. In the following sections these procedural steps are discussed.

(1) Data Collection Instrument

A list of follow-up questions asked of the non-respondent sample is presented in Exhibit 11. This data collection effort as well as that of the first study survey described in Chapter III were considered follow-ups to the original EPA survey (OMB No. 158-R0165).

The list of questions in Exhibit 11 was designed to provide information which could be used to test for bias in the original survey responses. Data on intended corrective actions were also sought to help resolve the bias issue. However, a reestimation of the corrective action results was not performed because the data from the non-respondent survey was not directly compatable to the original survey data. Also, the revised population estimates of asbestos removal and other corrective activities are not included in the purview of the proposed rule.

(2) Sample of Non-Respondents

The sample of non-respondents was limited to approximately 120 school districts. For consistency, the sample of non-respondent school districts were grouped into the same twenty-four clusters utilized in the original survey. Each cluster in the non-respondent survey had the same number of school districts. By having the same number of non-respondent school districts in each cluster, it was possible to obtain at least, a minimum response from each, regardless of how small. This procedure resulted in approximately five sample school districts in each cluster for the non-respondent survey.

Prior to sample selection we examined the implications of sampling five school districts in each cluster of the non-respondent survey. With this allocation, we anticipated that a difference of 30-35% in the percentage of affected districts between the original and the non-respondent sample in each cluster would be statistically significant at the 90% level of confidence.

EXHIBIT 11

Non-Respondent School Districts Data Collection Instrument

1. Do you remember receiving an EPA Voluntary Asbestos Survey Report last summer?

   If no -- skip to question #3

2. Do you remember what happened to it?

3. How many schools in your district were built or remodeled between 1945 - 1978?

4. How many of these schools have been inspected for friable materials?

   A. If none - ask: Have any plans been made to inspect the schools for friable materials?

      (1) Yes - ask: When? Based on your general knowledge of the schools in your district, how many contain friable materials?
         (a) If plans for corrective actions have been made, what are they?
         (b) If no plans have been made, STOP.

      (2) No - ask: based on construction records or your knowledge of the general condition of the Buildings, how many have friable materials?

         (a) If based on their knowledge of the schools, none have friable materials, STOP.

(b) If some have friable materials, have any plans been made to correct the situation?

- If plans have been made, what are they?
- If no plans have been made, STOP.

B. If any - go to Question 5.

5. How many of the inspected schools have any friable material?

6. Who conducted the inspection?

If the answer to Question 5 is none, STOP.

7. Were any bulk samples of this friable material taken?

If no -- ask: Have any plans been made to bulk sample areas with friable materials to check for asbestos content? If yes - ask when.

8. In how many schools were samples taken?

9. What were the results of the analysis of the bulk samples?

If negative - STOP.

If results are not back - What does he suspect the results will be based on construction plans or his knowledge of the schools?

10. Are you aware of EPA's suggested way of handling friable asbestos materials?

If no - STOP.

11. What corrective method have you planned on using?

Smaller differences might be due to sampling error, rather than a real difference between the two percentages.

A simple random sample of five or six school districts was then selected from districts which had not responded to the original survey. Certain states were excluded from the selection process because a summary of the Voluntary EPA Survey data indicated that no school districts in these states had responded. It is believed by EPA that this was due to the Boards of Education in these states having made other arrangements with the school districts, and that to attempt to sample them again would be futile. Therefore, the States of Alabama, Arkansas, Georgia, Hawaii, Indiana, Rhode Island, Vermont, Florida and Maryland were not included in the non-respondent sample.

(3) Data Collection

All data were collected by telephone. Names and telephone numbers of the sample school district superintendents were obtained from the State Boards of Education. A pretest of the data collection instrument consisting of approximatley ten percent of the school districts in the sample was made to evaluate its effectiveness. As a result of the pretest, a minor change was made, resulting in the addition of a question asking who had inspected the public schools for friable materials. This would provide a better basis for comparison with inspection data from the original survey.

(4) Analysis

The data, once compiled, was analyzed to identify differences between survey results. As a measure of such differences, the proportion of affected school districts in each cluster of non-respondent survey was computed and compared to the corresponding estimate of the original survey. The particular difference measure used for each cluster was:

$$D_i = \frac{P_o - P_{nr}}{\sqrt{\frac{P_{nr}(1-P)_{nr}}{N_r}}}$$

where:

D_i = the measure of difference between the original sample and the non-respondent survey for cluster i

P_{oi} = proportion of districts affected in the original sample for cluster i

P_{nri} = proportion of districts affected in the non-respondent sample for cluster i

N_{ri} = number of non-respondent districts sampled for cluster i.

When the number of sample cases of non-respondents is over twenty, the quantity D_i will be approximately normally distributed with a mean of zero and standard deviation of one, if P_{oi} is treated as a constant and thus not subject to sampling error. This is equivalent to treating the original responding school districts in each cluster as representing only themselves rather than as representing all districts in that cluster. Comparing the values of D_i to standard factors based on the normal distribution, gives a rough indication of which differences may be important. Comparison with the normal distribution is an approximation because the sample sizes in each cluster are small, but the values of D_i serve as a reasonable guide in examining the differences.

Based on the values of D, eight (8) of the twenty-four (24) clusters have differences that may be important (see Table 28). This result is based on identifying the clusters with values of D greater than 1.65, the factor from the standard normal distribution appropriate for performing a significance test at the 10% level. The particular clusters identified in this way are the following: 2, 6, 10(b), 10(d), 10(e), 11, 12, and 13.

These eight clusters were further examined to see if the difference was mainly due to one of the three factors mentioned earlier. Values of D_i were calculated in the eight clusters separately for the proportions of districts with schools needing bulk testing, with schools needing inspection, and with schools with exposure problems. In cluster 2, the difference appears to be in the bulk sampling estimates. In clusters 6 and 10(b) the apparent difference is in inspection estimates. In clusters 10(d) and 10(e) the difference is apparently in the exposure estimates. In the other clusters, the additional breakdown was not helpful in explaining the overall difference.

From these results it appears advisable to revise the cost estimates for the eight clusters. Three approaches to revision are conceivable: (1) averaging of the percentages of affected schools from the original and non-respondent samples, (2) pooling data from the two samples, or (3) a weighting scheme for the two samples other than pooling or simple averaging. The first alternative seems to us to be preferable because it gives an implicit weight to the non-respondent sample which is larger than would be implied by the relative sizes of the non-respondent sample and the original sample. Averaging gives each sample equal weight. For instance, in cluster 2, 23 districts responded originally and 5 non-respondents were contacted subsequently. In this cluster the average of the proportions of districts affected would be .41 (the average of .22 and .60). Weighting in proportion

TABLE 28

PROPORTIONS OF AFFECTED SCHOOL DISTRICTS AND SCHOOLS IN ORIGINAL AND NONRESPONDENT SAMPLE

	TOTAL AFFECTED SCHOOL DISTRICTS			TOTAL AFFECTED SCHOOLS	
STRATA	ORIGINAL SAMPLE 1/	NON-RESPONDENT SAMPLE 2/	VALUE OF d 3/	ORIGINAL SAMPLE 4/	NON-RESPONDENT SAMPLE 5/
1	.13	.33	1.04	.11	
2	.22	.60	1.73	.77	.36
3	.11	.20	.09	.17	
4	.25	.40	.68	.07	
5	.45	.20	1.40	.09	
6	0	.40	1.83	0	.23
7	.50	.40	.46	.17	
8	.18	.20	.11	.31	
9	.14	.33	.99	.05	
10(a)	.66	.40	1.30	.10	
10(b)	0	.40	1.83	0	.30
10(c)	.20	.40	.91	.04	
10(d)	1.00	.40	2.74	.24	.02
10(e)	1.00	.20	4.47	.07	.28
11	.20	.60	1.83	.15	.61
12	.75	.33	2.19	.21	.16
13	.50	.20	1.68	.17	.08
14	.25	.25	0	.03	
15	0	.17	1.11	0	
16	0	.20	1.12	0	
17	.35	.60	1.14	.15	
18	.29	.25	.21	.13	
19	.33	0	0	.07	
20	.25	.20	.28	.37	

1/ Proportion of Affected School Districts in Original Sample = $\left(\frac{\text{Affected School Districts}}{\text{Total School Districts}}\right) = P_o$

2/ Proportion of Affected School Districts in Non-Respondent Sample = $\left(\frac{\text{Affected School Districts}}{\text{Total School Districts}_{nr}}\right)_{nr} = P_N$

3/ $d = (P_o - P_{nr}) \,/\, \sqrt{P_{nr}\,(1 - P_{nr})/n_{nr}}$, n_{nr} = number of sample districts in nonrespondent sample

4/ Proportion of Affected Schools in Original Sample = $\left(\frac{\text{Affected Schools}}{\text{Total Schools}_o}\right)_o$

5/ Proportion of Affected Schools in Non-Respondent Sample = $\left(\frac{\text{Affected Schools}}{\text{Total Schools}_{nr}}\right)_{nr}$

to numbers of districts in the sample, on the other hand, would give the original sample a weight of 5/28, resulting in a weighted estimate of districts affected of .28. Equal weighting is justifiable on the grounds that the non-respondent sample is a random, probability sample from the entire cluster (excluding the original respondents), while the original respondents can be said to represent only themselves. Thus, from that point of view, disproportionately weighting the non-respondent sample, compared to its proportion of the combined sample, is a rational procedure. The averaging procedure was the basis for all cost estimate revisions.

(5) Revisions of Affected Population and Cost Estimates

A reestimation of the original affected population data (see Table 5 through 10 in Chapter III) was necessary because of a bias found in eight (8) of the clusters and because the proposed rule has revised requirements regarding inspection and bulk testing. Exhibit 12 provides estimates of the number of public schools and school districts affected by the proposed "rule". Exhibit 13 presents estimates of the number of schools requiring inspection, bulk testing and those with exposure problems (i.e., schools with buildings that have friable asbestos-containing materials). Exhibit 14 provides similar (to Exhibit 13) data at the school district level.

It should be noted that estimates of the number of affected schools and school districts are different from the original estimates even in some clusters where bias was not found. This is because the proposed rule differs in terms of regulatory scope from that of the original study.

The data in Exhibit 14 on the proportion of school districts in each cluster requiring either inspection or bulk testing were

EXHIBIT 12

ESTIMATES OF THE NUMBER OF SCHOOL DISTRICTS, SCHOOLS AND STUDENTS AFFECTED BY RULE 1 IN THE SAMPLE AND POPULATION

	SAMPLE			POPULATION		SAMPLE			POPULATION		SAMPLE			POPULATION	
STRATA	%[1]	TOTAL SCHOOL DISTRICTS	AFFECTED SCHOOL DISTRICTS	TOTAL SCHOOL DISTRICTS	ESTIMATES[2] OF AFFECTED SCHOOL DISTRICTS	%[3]	TOTAL SCHOOLS	AFFECTED SCHOOLS	TOTAL SCHOOLS	ESTIMATES[4] OF AFFECTED SCHOOLS	%	TOTAL STUDENTS	AFFECTED STUDENTS	TOTAL STUDENTS IN SCHOOL DISTRICTS	AFFECTED STUDENTS
1	.13	32	4	3,105	404	.05	111	6	7,462	373	.04	43,870	1,857	2,691,124	107,645
2[5]	.51	28		4,650	2,372	.31	79		9,731	3,015	.25	4,362		1,949,125	487,281
3	.11	9	1	1,011	112	.17	18	3	2,014	342	0	6,203	0	504,358	0
4	.25	36	9	670	168	.05	512	27	8,420	444	.02	224,527	4,832	3,947,294	78,946
5	.46	11	5	224	103	.09	128	12	4,832	435	.11	65,667	7,175	1,964,797	216,128
6[5]	.20	8		69	14	.11	[illegible]		384	43	0	33,694		219,808	0
7	.50	2	1	51	26	.17	12	2	275	47	0	8,311	0	161,997	0
8	.56	16	9	1,743	975	.29	62	18	4,555	1,321	.24	24,856	6,049	2,024,747	485,939
9	.14	7	1	684	96	.05	21	1	1,660	81	0	9,413	0	486,436	0
10(a)	.75	12	9	38	29	.09	812	75	1,566	141	.11	590,539	65,893	1,064,751	117,123
10(b)[5]	.30	6		70	21	.16[6]	217		3,539	567	.20	125,120		2,263,282	462,656
10(c)	.20	5	1	75	15	.04	266	10	2,497	100	0	180,838	0	1,690,524	0
10(d)[5]	.71	7		17	12	.13[6]	6		954	124	.30	219,489		524,108	157,232
10(e)[5]	.61	7		41	25	.18[6]	140		2,415	435	.07	255,180		1,623,641	113,654
11[5]	.40	21		547	219	.44[6]	59		1,123	494	.52	17,766		388,863	202,209
12[5]	.54	16		68	37	.25[6]	7		577	144	.24	3,380		101,079	24,259
13[5]	.35	9		156	55	.13[6]	152		2,894	376	.04	89,280		1,919,292	76,771
14	.25	4	1	267	67	.03	33	1	4,807	144	0	16,438	0	2,986,076	0
15	0	3	0	216	0	0	26	0	9,937	0	0	7,112	0	370,299	0
16	.67	1	2	81	54	0	32	0	1,014	0	0	18,898	0	449,343	0
17	.38	23	8	862	328	.10	203	21	14,682	1,415	.03	97,996	3,179	8,159,773	244,793
18	.29	14	4	669	194	.13	72	9	4,425	575	.07	42,226	3,209	2,999,695	209,979
19	.33	3	1	7[illegible]	21	.07	15	1	353	25	.06	9,899	625	295,536	17,732
20	.25	4	1	372	93	.37	51	19	2,491	922	0	20,234	0	1,360,623	0
TOTAL					5,442					11,568					2,992,347

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[1] Percentage of Affected School Districts = $\frac{\text{Affected School Districts}}{\text{Total School Districts}}$

[2] Estimates of Affected School Districts in the Population = (Total SD in Population) (Percentage of Affected SD in Sample)

[3] Percentage of Affected Schools = $\frac{\text{Affected Schools}}{\text{Total Schools}}$

[4] Estimates of Affected Schools in Population = (Total Schools in Population) (Percentage of Affected Schools in Sample)

[5] Weighted Average of Original Study Sample and Non-Respondent Sample = $\frac{\left(\frac{\text{Affected School Districts}}{\text{Total School Districts}}\right)_o + \left(\frac{\text{Affected School Districts}}{\text{Total School Districts}}\right)_{nr}}{2}$

[6] Weighted Average of Original Study Sample and Non-Respondent Sample = $\frac{\left(\frac{\text{Affected Schools}}{\text{Total Schools}}\right)_o + \left(\frac{\text{Affected Schools}}{\text{Total Schools}}\right)_{nr}}{2}$

EXHIBIT 13

ESTIMATES OF THE NUMBER AND DEGREE TO WHICH SCHOOLS IN THE SAMPLE AND POPULATION ARE AFFECTED BY RULE 1

	SAMPLE							POPULATION			
STRATA	TOTAL AFFECTED SCHOOLS	%	SCHOOLS NEEDING 1/INSPECTION	%	SCHOOLS NEEDING 1/BULK TESTING		SCHOOLS WITH 1/EXPOSURE PROBLEMS	TOTAL AFFECTED SCHOOLS	SCHOOLS NEEDING 2/ INSPECTION	SCHOOLS NEEDING 2/ BULK TESTING	SCHOOLS WITH 2/ EXPOSURE PROBLEMS
1	6	.33	2	.16	1	1.00	6	373	123	60	373
2 3/		.40		.30		.70		3035	1,214	911	2,124
3	3					1.00	3	342			342
4	27					1.00	27	444			444
5	12					1.00	12	435			435
6 3/		.50						43 4/	43		
7	2					1.00	2	47			47
8	18	.61	11	.61	11	.37	18	1,321	806	806	489
9	1					1.00	1	83			83
10(a)	75					1.00	75	141			141
10(b) 3/		.39		.11		.11		637 4/	496	140	140
10(c)	10			.50	5	.50	5	100		50	50
10(d) 3/						1.00		124			124
10(e) 3/		.50				.50		435	218		217
11 3/		.41				.59		494	202		291
12 3/		.44		.50		.94		144	63	72	135
13 3/						1.00		376			376
14	1					1.00	1	144			144
15	0							0			
16	0							0			
17	21					1.00		1,415			1,415
18	9					1.00	9	575			575
19	1			1.00	1			25		25	
20	19			1.00	19			922		922	
TOTAL								11,588	3,165	2,936	8,545

1/ Percentage of Affected Schools Needing a Specific Action = $\left(\frac{\text{Number of Affected Schools}}{\text{Total Affected Schools}_j}\right)_{ij} = SA_{ij}$ Where: i = 1-20
j = specific action

2/ Estimates of Schools in Population Requiring a Specific Action = $(\text{Total Affected Schools}_P)$ (Percentage of Affected Schools Needing the Specific Action (ie. Inspection))

3/ Weighted Average of Original Study Sample and Non-Respondent Sample = $\dfrac{\left(\dfrac{\text{Affected Schools Requiring a Specific Action}}{\text{Total Schools}_o}\right)_o + \left(\dfrac{\text{Affected Schools Requiring A Specific Action}}{\text{Total Schools}_{Nr}}\right)_{Nr}}{2}$

4/ In these strata the fact that no schools were affected in one of the samples leads to an inconsistency in the sum of the number of schools requiring a specific action and the estimated total number of affected schools when the calculation in footnote 3 is performed. In these strata the number needing a specific action was doubled.

EXHIBIT 14

ESTIMATES OF THE PERCENTAGE OF A SCHOOL DISTRICT WHICH WILL ON THE AVERAGE BE REQUIRED TO TAKE A SPECIFIC ACTION

STRATA	INSPECTION [1/]	BULK TESTING [1/]	EXPOSURE PROBLEMS [1/]
1	2.0%	4.2%	4.3%
2 [2/]	2.7	2.68	7.5
3	0	0	8.3
4	2.3	.8	6.0
5	0	0	13.5
6 [2/]	8.1	0	0
7	0	0	50.0
8	19.8	17.9	29.3
9	0	0	7.1
10(a)	0	0	0
10(b) [2/]	11.8	1.54	1.54
10(c)	0	0	0
10(d) [2/]	0	0	4.1
10(e) [2/]	0	0	2.4
11 [2/]	7.[illegible]	0	6.4
12 [2/]	5.0	5.7	10.8
13 [2/]	2.1	0	3.7
14	0	0	2.8
15	0	0	0
16	0	0	0
17	1.3	0	10.7
18	0	0	10.6
19	20.0	6.7	0
20	0	22.5	0

[1/] Percentage of a School District requiring a Specific Action:

Where: i = 1-20

j = specific action

k = school district

$$\frac{\left(\hat{\Sigma}_{k=1} \frac{\text{(Schools Req. Specific Action)}}{\text{Total Schools}} \right)}{\text{Total School Districts}}$$

[2/] Percentage of a School District Requiring a Specific Action =

$$\frac{\left(\Sigma \frac{\text{Affected Schools}}{\text{Total Schools}}_{o} + \Sigma \frac{\text{Affected Schools nr}}{\text{Total Schools nr}} \right) \div (\text{Total Districts}_{o} + \text{Total Districts}_{nr})}{2}$$

utilized to reestimate total (national) costs. Total costs by cluster for inspection and bulk testing (both polarized light microscopy and X-ray diffraction) are presented in Exhibit 15.

The methodology utilized for the cost estimation is similar to that employed in the draft report, except for revisions made to the bulk testing costing procedure. The changes in the costing methodology (from those employed in Chapter IV above) are several. First, in the revised bulk testing formula, the number of bulk samples required on the average in an affected public school has been assumed to range between three and seven. The cost for each bulk test is, therefore, presented in terms of this range, rather than according to the number of square feet of asbestos, the multiplier used in the original analysis. Second, Exhibit 15 incorporates the revised unit cost estimates. These revised unit cost estimates, as discussed, were developed without outliers in the sample of testing laoratories. Finally, the inspection costs are substantially different from the original estimates. This is due in part to changes as a result of bias correction and, in part to the fact that the costs reestimates are specific only to the proposed rule. They do not include those school districts (as in the original study) that required periodic reinspection of encapsulated or enclosed asbestos containing materials.

EXHIBIT 15

TOTAL NATIONAL COSTS FOR INSPECTION AND BULK TESTING

	CLUSTER	TOTAL INSPECTION COST	TOTAL PETROGRAPHIC MICROSCOPY COST 3-test minimum	TOTAL PETROGRAPHIC MICROSCOPY COST 7-test maximum	TOTAL X-RAY DIFFRACTION COST 3-test minimum	TOTAL X-RAY DIFFRACTION COST 7-test maximum
	1	$ 2,398	$30,680	$71,587	$53,700	$125,301
	2	1,523	17,650	41,183	32,967	76,923
	3	0	0	0	0	0
	4	511	1,542	3,598	2,978	6,489
	5	0	0	0	0	0
	6	0	0	0	0	0
	7	0	0	0	0	0
	8	7,477	46,699	108,963	88,145	205,680
	9	0	0	0	0	0
10	1	0	0	0	0	0
	2	1,231	834	1,946	1,620	3,780
	3	0	0	0	0	0
	4	0	0	0	0	0
	11	11,434	0	0	0	0
	12	144	1,775	4,141	2,686	6,267
	13	264	0	0	0	0
	14	0	0	0	0	0
	15	0	0	0	0	0
	16	0	0	0	0	0
	17	608	0	0	0	0
	18	0	0	0	0	0
	19	0	0	0	0	0
	20	0	29,989	69,974	50,893	118,750
	TOTAL	$25,590	$129,169	$301,392	$232,989	$543,190

VI. SUMMARY

The original survey and subsequent non-respondent survey provided data to estimate the population affected and the cost of the proposed rule. In this chapter, a summary of the survey and analysis results are presented. These results are presented in the form of national totals and include the number of affected public schools, school districts and students. The number of affected public schools is broken-down by required inspection and bulk testing activities under the proposed rule, and the estimated cost of compliance. Finally, the results of a risk analysis to estimate the number of students and teaching and non-teaching staff at risk are presented.

1. ESTIMATED POPULATIONS AFFECTED

The revised population estimates for the number of school districts and public schools affected for the individual clusters are presented in Exhibit 12. The national totals are presented below:

Affected School Districts:	5,442 out of an estimated U.S. total of 15,854 (34%)
Affected Public Schools:	11,588 out of an estimated U.S. total of 91,667 (12.6%)
Affected Students:	2,992,347 out of an estimated U.S. total of 40.1 million students (7%).

The estimate for total schools affected was further divided according to the type of activity required of them under the proposed rule. The number of affected schools add up to more than the total, as some schools will require more than one type of action. Estimates of schools needing a specific action (or with exposure problems) are as follows (see exhibit 13):

Inspection:	3,165
Bulk Testing:	2,936
Exposure problems:	8,545

2. ESTIMATED COSTS OF THE PROPOSED RULE

The estimated total national costs for inspection and bulk testing as required in the proposed rule are as follows (see exhibit 15):

- Total National Inspection Cost: $25,590
- Total National Bulk Testing Cost:
  - For Petrographic Microscopy Testing
    - Three tests per affected school - $129,169
    - Seven tests per affected school - $301,392
  - For X-Ray Diffraction Testing
    - Three tests per affected school - $232,989
    - Seven tests per affected school - $543,190

Two sets of bulk testing costs, based on three samples and seven samples per sampling area,were developed because most bulk testing situations are expected to fall within this range. Three samples is the minimum number required under the proposed rule. The need, according to EPA estimates, may increase to as much as seven samples in instances where sampling areas are large or where re-tests have to be conducted due to inconclusive initial tests.

3. POPULATIONS POTENTIALLY AT RISK

There are a large number of students and teachers and non-teaching staff that are at risk and that can potentially benefit from this rule. The estimated number of students that are at risk is assumed to be the number of students affected by the proposed rule. This estimate is 2,992,347 students nationwide. This estimate was used as a basis for determining the number of teachers and support staff also at risk.

Categories of educational staff were established to determine the estimated potential number being exposed to asbestos risk and who could benefit from the rule. The staff categorizations were based on National Center for Education Statistics classifications.

For each category of educational staff, a staff to student ratio was developed. These ratios use the actual number of students nationwide, and the number of employees in each staff category (teachers, professional staff, etc.) for the universe of primary and secondary public schools. These data were obtained from the National Center for Education Statistics. On the basis of these ratios and our national estimate of students potentially at risk and benefitting from the proposed rule, the number of staff potentially at risk was estimated . The results of this analysis are displayed in Exhibit 16.

EXHIBIT 16

STUDENTS AND STAFF AT RISK FROM ASBESTOS

Educational Staff Category	Staff Category to Student Ratio	Estimated Number Removed from Potential Risk
Students	N/A	2,992,347
Classroom teachers 1/	0.5	149,617
Officials/Administrative & Non-professional workers 2/	.035	104,732
Professional/Educational 3/	.005	14,962
Total Students & Staff Removed from Potential Risk		3,261,658

1/ "Classroom teachers" is defined as "a person employed to instruct pupils in a situation where the teacher and the pupils are in the presents of each other."

2/ Category included as official & administrator are:

Superintendent, Assistant, Deputy, Associate Superintendents, Principals, Assistant Principals, Admin. Assistant, Admin. Interns, Foremen, Ombudsmen, Supervisor, Manager, Director, Tax Assessor/Collector.

And included as non-professional workers are:

Teaching Aides, Teaching Interns, Teaching Assistants. Bookkeeper, Clerk, Messenger, Records Manager, Technical Staff, Office/Clerical, Crafts and Trades, Operative, Laborers, Service Workers.

3/ Categories inlcuded as professional/educators are:

Curriculum Specialists, Counselors, Librarians, Media Specialists, Remidial Specialists, Accountants, Analysts, Architects, Audiologists, Auditory Personnel, Dentists, Dietitians/Nutritionists, Editors, Engineers, Evaluators, Legal Workers, Negotiators, Opthamologists, Optometrists, Personnel Dept. Physician Planner, Psychiatrists/Psychologists/Public/Community Relations, Nurse, Registrar Research & Devp., Social Workers, Statisticians, Therapists.

APPENDIX A

Estimated Average Asbestos Square Footage per Affected School District by Cluster

APPENDIX A

Estimated Average Asbestos Square Footage Per Affected School District By Cluster

CLUSTER	AVERAGE SQUARE FOOTAGE OF ASBESTOS PER AFFECTED SCHOOL DISTRICT	AVERAGE NUMBER OF AFFECTED SCHOOL PER AFFECTED SCHOOL DISTRICT
1	62,767	2.5
2	14,000	2
3	0	0
4	7,174	2.6
5	59,340	2.5
6	0	0
7	0	0
8	22,021	1.3
9	800	1
10	236,036	7.7
11	300	1
12	26,461	1.5
13	5,000	2
14	0	0
15	0	0
16	0	0
17	44,205	3
18	42,773	2.2
19	0	0
20	3,446	3

APPENDIX B

State Level Cost Estimates by Cluster
Corrective Action

STATE CODE INDEX

STATE NAME	STATE CODE
Alabama	10
Alaska	11
Arizona	12
Arkansas	13
California	14
Colorado	15
Connecticut	16
Delaware	17
District of Columbia	18
Florida	19
Georgia	20
Hawaii	21
Idaho	22
Illinois	23
Indiana	24
Iowa	25
Kansas	26
Kentucky	27
Louisiana	28
Maine	30
Maryland	31
Massachusetts	31
Michigan	32
Minnesota	33
Mississippi	34
Missouri	35
Montana	36
Nebraska	37
Nevada	38
New Hampshire	39
New Jersey	40
New Mexico	41
New York	42
North Carolina	43
North Dakota	44
Ohio	45
Oklahoma	46
Oregon	47
Pennsylvania	48
Rhode Island	49
South Carolina	50
South Dakota	51
Tennessee	52
Texas	53
Utah	54
Vermont	55
Virginia	56
Washington	57
West Virginia	58
Wisconsin	59
Wyoming	60

Cost of Corrective Actions by State

CLUSTER 1

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
10	23	225.	398.	1634.	607.	81075.	0	0	0	0	0
16	46	451.	796.	3267.	1214.	162150.	0	0	0	0	0
17	5	49.	87.	355.	132.	17625.	0	0	0	0	0
19	10	98.	173.	710.	264.	35250.	0	0	0	0	0
20	81	794.	1401.	5753.	2138.	285525.	0	0	0	0	0
23	427	4185.	7387.	30330.	11269.	1505175.	0	0	0	0	0
24	97	951.	1678.	6890.	2560.	341925.	0	0	0	0	0
27	80	784.	1384.	5682.	2111.	282000.	0	0	0	0	0
29	250	2450.	4325.	17758.	6598.	881250.	0	0	0	0	0
31	141	1382.	2439.	10015.	3721.	497025.	0	0	0	0	0
32	217	2127.	3754.	15414.	5727.	764925.	0	0	0	0	0
33	306	2999.	5294.	21735.	8075.	1078650.	0	0	0	0	0
34	59	578.	1021.	4191.	1557.	207975.	0	0	0	0	0
39	113	1107.	1955.	8026.	2982.	398325.	0	0	0	0	0
40	87	853.	1505.	6180.	2296.	306675.	0	0	0	0	0
42	272	2666.	4706.	19320.	7178.	958800.	0	0	0	0	0
43	23	225.	398.	1634.	607.	81075.	0	0	0	0	0
45	190	186.	3287.	13496.	5014.	669750.	0	0	0	0	0
48	93	911.	1609.	6606.	2454.	327825.	0	0	0	0	0
49	8	78.	138.	568.	211.	28200.	0	0	0	0	0
50	27	265.	467.	1918.	713.	95175.	0	0	0	0	0
55	235	2303.	4066.	16692.	6202.	828375.	0	0	0	0	0

Cost of Corrective Actions by State

CLUSTER 1 Cont'd

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
56	37	363.	640.	2628.	976.	130425.	0	0	0	0	0
58	8	78.	138.	568.	211.	28200.	0	0	0	0	0
59	270	2646.	4671.	19178.	7125.	951750.	0	0	0	0	0

Cost of Corrective Actions by State

CLUSTER 2

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
13	299	471.	0	0	0	201681.	868009.	24111.	13492.	12730.	8743.
15	126	199.	0	0	0	84990.	365783.	10161.	5686.	5364.	3684.
25	363	572.	0	0	0	244851.	1053804.	29272.	16380.	15454.	10614.
26	239	377.	0	0	0	161210.	693827.	19273.	10785.	10175.	6988.
28	4	6.	0	0	0	2698.	11612.	323.	180.	170.	117.
35	389	613.	0	0	0	262388.	1129283.	31369.	17553.	16561.	11374.
36	534	842.	0	0	0	360194.	1550223.	43062.	24096.	22734.	15614.
37	1060	1672.	0	0	0	714991.	3077222.	85478.	47831.	45128.	30994.
41	58	91.	0	0	0	39122.	168376.	4677.	2617.	2469.	1696.
44	301	475.	0	0	0	203031.	873815.	24273.	13582.	12815.	8801.
46	433	683.	0	0	0	292067.	1257016.	34917.	19539.	18434.	12661.
51	149	235.	0	0	0	100503.	432553.	12015.	6723.	6343.	4357.
53	641	1011.	0	0	0	432367.	1860849.	51690.	28924.	27290.	18742.
54	16	25.	0	0	0	10792.	46449.	1290.	722.	681.	468.
60	38	60.	0	0	0	25632.	110316.	3064.	1715.	1618.	1111.

Cost of Corrective Actions by State

CLUSTER 3

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
11	30	0	0	0	0	0	0	0	0	0	0
12	133	0	0	0	0	0	0	0	0	0	0
14	385	0	0	0	0	0	0	0	0	0	0
22	88	0	0	0	0	0	0	0	0	0	0
38	7	0	0	0	0	0	0	0	0	0	0
47	194	0	0	0	0	0	0	0	0	0	0
57	174	0	0	0	0	0	0	0	0	0	0

Cost of Corrective Actions by State

CLUSTER 4

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
17	4	26.	0	0	0	84.	2324.	172.	50.	111.	18.
19	27	178.	0	0	0	570.	581.	1161.	337.	750.	124.
20	24	158.	0	0	0	506.	13946.	1032.	300.	667.	110.
23	25	165.	0	0	0	528.	14528.	1075.	312.	695.	115.
24	48	317.	0	0	0	1013.	27893.	2064.	599.	1333.	221.
27	35	231.	0	0	0	739.	20339.	1505.	437.	972.	161.
30	12	79.	0	0	0	253.	6973.	516.	150.	333.	55.
31	4	26.	0	0	0	84.	2324.	172.	50.	111.	18.
32	35	231.	0	0	0	739.	20339.	1505.	437.	972.	161.
33	16	106.	0	0	0	338.	9298.	688.	200.	445.	74.
34	56	370.	0	0	0	717.	32542.	2408.	699.	1556.	258.
39	2	13.	0	0	0	42.	1162.	86.	25.	56.	9.
40	3	20.	0	0	0	63.	1743.	129.	37.	83.	14.
43	79	521.	0	0	0	1667.	45907.	3397.	986.	2195.	363.
45	44	290.	0	0	0	928.	25568.	1892.	549.	1222.	202.
48	61	403.	0	0	0	1287.	35447.	2623.	761.	1695.	281.
49	2	13.	0	0	0	42.	1162.	86.	25.	56.	9.
50	35	231.	0	0	0	739.	20339.	1505.	437.	972.	161.
52	64	422.	0	0	0	1350.	37190.	2752.	799.	1778.	294.
55	3	20.	0	0	0	63.	1743.	129.	37.	83.	14.
56	48	317.	0	0	0	1013.	27893.	2064.	599.	1333.	221.
58	33	218.	0	0	0	696.	19176.	1419.	412.	917.	152.
59	10	66.	0	0	0	211.	5811.	430.	125.	279.	46.

Cost of Corrective Actions by State

CLUSTER 5

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
13	5	29.	0	0	0	28697.	48656.	1012.	209.	246.	186.
15	10	57.	0	0	0	57393.	97312.	2023.	419.	492.	373.
25	15	86.	0	0	0	86090.	145968.	3035.	628.	738.	559.
26	15	86.	0	0	0	86090.	145968.	3035.	628.	738.	559.
28	43	246.	0	0	0	246792.	418441.	8700.	1801.	2115.	1602.
35	17	97.	0	0	0	97569.	165430.	3440.	712.	836.	634.
36	3	17.	0	0	0	17218.	29194.	607.	126.	148.	112.
37	5	29.	0	0	0	28697.	48656.	1012.	209.	246.	186.
41	21	120.	0	0	0	120526.	204355.	4249.	880.	1033.	783.
44	5	29.	0	0	0	28697.	48656.	1012.	209.	246.	186.
46	12	69.	0	0	0	68872.	116774.	2428.	503.	590.	447.
51	8	46.	0	0	0	45915.	77849.	1619.	335.	393.	298.
53	39	223.	0	0	0	223834.	379516.	7891.	1634.	1918.	1453.
54	11	63.	0	0	0	63133.	107043.	2226.	461.	541.	410.
60	9	51.	0	0	0	51654.	87581.	1821.	377.	443.	335.

Cost of Corrective Actions by State

CLUSTER 6

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
13	17	0	0	0	0	0	0	0	0	0	0
15	3	0	0	0	0	0	0	0	0	0	0
25	1	0	0	0	0	0	0	0	0	0	0
26	2	0	0	0	0	0	0	0	0	0	0
28	1	0	0	0	0	0	0	0	0	0	0
35	4	0	0	0	0	0	0	0	0	0	0
36	2	0	0	0	0	0	0	0	0	0	0
37	4	0	0	0	0	0	0	0	0	0	0
41	3	0	0	0	0	0	0	0	0	0	0
44	2	0	0	0	0	0	0	0	0	0	0
46	3	0	0	0	0	0	0	0	0	0	0
51	2	0	0	0	0	0	0	0	0	0	0
53	23	0	0	0	0	0	0	0	0	0	0
60	2	0	0	0	0	0	0	0	0	0	0

Cost of Corrective Actions by State

Cluster 7

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
12	14	0	0	0	0	0	0	0	0	0	0
14	10	0	0	0	0	0	0	0	0	0	0
22	4	0	0	0	0	0	0	0	0	0	0
38	2	0	0	0	0	0	0	0	0	0	0
47	10	0	0	0	0	0	0	0	0	0	0
57	11	0	0	0	0	0	0	0	0	0	0

Cost of Corrective Actions by State

Cluster 8

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
10	12	98.	0	0	0	63595.	0	0	0	0	0
16	38	312.	0	0	0	201385.	0	0	0	0	0
17	1	8.	0	0	0	5300.	0	0	0	0	0
19	1	8.	0	0	0	5300.	0	0	0	0	0
20	9	74.	0	0	0	47696.	0	0	0	0	0
23	297	2435.	0	0	0	1573981.	0	0	0	0	0
24	51	418.	0	0	0	270280.	0	0	0	0	0
27	12	98.	0	0	0	63595.	0	0	0	0	0
29	9	74.	0	0	0	47696.	0	0	0	0	0
31	86.	705.	0	0	0	455766.	0	0	0	0	0
32	115	943.	0	0	0	609454.	0	0	0	0	0
33	60	492.	0	0	0	317976.	0	0	0	0	0
34	5	41.	0	0	0	26498.	0	0	0	0	0
39	26	213.	0	0	0	137790.	0	0	0	0	0
40	337	2763.	0	0	0	1785965.	0	0	0	0	0
42	243	1993.	0	0	0	1287803.	0	0	0	0	0
43	1	8.	0	0	0	5300.	0	0	0	0	0
45	212	1738.	0	0	0	1123515.	0	0	0	0	0
48	123	1009.	0	0	0	651851.	0	0	0	0	0
49	7	57.	0	0	0	37097.	0	0	0	0	0
50	6	49.	0	0	0	31798.	0	0	0	0	0
56	6	49.	0	0	0	31798.	0	0	0	0	0
58	1	8.	0	0	0	5300.	0	0	0	0	0
59	75	615.	0	0	0	397470.	0	0	0	0	0

Cost of Corrective Actions by State

Cluster 9

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
13	44	1157.	0	0	0	0	0	0	0	0	0
15	18	473.	0	0	0	0	0	0	0	0	0
25	32	842.	0	0	0	0	0	0	0	0	0
26	33	868.	0	0	0	0	0	0	0	0	0
35	75	1973.	0	0	0	0	0	0	0	0	0
36	37	973.	0	0	0	0	0	0	0	0	0
37	34	894.	0	0	0	0	0	0	0	0	0
41	2	53.	0	0	0	0	0	0	0	0	0
44	12	316.	0	0	0	0	0	0	0	0	0
46	145	3814.	0	0	0	0	0	0	0	0	0
51	6	158.	0	0	0	0	0	0	0	0	0
53	249	6549.	0	0	0	0	0	0	0	0	0

Cost of Corrective Actions by State

CLUSTER 10 REGION 3

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
18	1	21	0	0	0	62,768	28,486	1,656	61	101	24
30	1	21	0	0	0	62,768	28,486	1,656	61	101	24
48	22	463	0	0	0	1,380,892	626,700	36,427	1349	2221	533
56	11	231	0	0	0	690,446	313,350	18,213	674	1111	267
58	3	63	0	0	0	188,303	85,459	4,967	184	303	73

Cost of Corrective Actions by State

CLUSTER 10 REGION 6

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost Optical Microscopy
13	5	105	0	0	0	0	0	0	0	0	0
28	5	105	0	0	0	0	0	0	0	0	0
41	1	21	0	0	0	0	0	0	0	0	0
46	5	105	0	0	0	0	0	0	0	0	0
53	59	1241	0	0	0	0	0	0	0	0	0

Cost of Corrective Actions by State

CLUSTER 10 REGION 7

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
25	7	309	0	0	0	1,051,361	0	0	0	0	0
26	3	132	0	0	0	450,583	0	0	0	0	0
35	5	220	0	0	0	750,972	0	0	0	0	0
37	2	88	0	0	0	300,389	0	0	0	0	0

Cost of Corrective Actions by State

CLUSTER 10 REGIONS 9-10

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
12	2	39	0	0	0	159,909	256,377	14,902	552	909	218
14	28	553	0	0	0	2,238,719	3,589,281	208,625	7724	12,721	3,054
22	1	20	0	0	0	79,954	128,189	7,451	276	454	109
47	3	59	0	0	0	239,863	384,566	22,353	828	1,363	327
57	7	138	0	0	0	559,680	897,320	52,156	1931	3,180	764

Cost of Corrective Actions by State

Cluster 11

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
12	49	73.5	0	0	0	1377.	0	0	0	0	0
14	362	543.	0	0	0	10172.	0	0	0	0	0
22	1	2.	0	0	0	28.	0	0	0	0	0
47	85	128.	0	0	0	2389.	0	0	0	0	0
57	50	75.	0	0	0	1405.	0	0	0	0	0

Cost of Corrective Actions by State

Cluster 12

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
13	1	4.	0	0	0	2306.	5457.	111.	34.	43.	28.
15	3	13.	0	0	0	6917.	16370.	333.	103.	128.	83.
25	17	71.	0	0	0	39199.	92766.	1889.	585.	723.	473.
26	6	25.	0	0	0	13835.	32741.	667.	206.	255.	167.
28	1	4.	0	0	0	2306.	5457.	111.	34.	43.	28.
35	2	8.	0	0	0	4612.	10914.	222.	69.	85.	56.
36	4	17.	0	0	0	9223	21827.	444.	138.	170.	473.
41	2	8.	0	0	0	4612.	10914.	222.	69.	85.	56.
44	1	4.	0	0	0	2306.	5457.	111.	34.	43.	28.
46	5	21.	0	0	0	11529.	27284.	556.	172.	213.	139.
51	20	84.	0	0	0	46116.	109136.	2222.	688.	850.	556.
54	2	8.	0	0	0	4612.	10914.	222.	69.	85.	56.
60	4	17.	0	0	0	9223.	21827.	444.	138.	170.	111.

Cost of Corrective Actions by State

Cluster 13

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
13	5	26.	0	0	0	0	7560.	158.	218.	211.	166.
15	18	94.	0	0	0	0	27216.	567.	783.	760.	598.
25	10	52.	0	0	0	0	15120	315.	435.	422.	332.
26	5	26.	0	0	0	0	7560.	158.	218.	211.	166.
28	12	62.	0	0	0	0	93744.	378.	522.	506.	398.
35	32	166.	0	0	0	0	48384.	1008	1392.	1350.	1062.
36	1	5.	0	0	0	0	1512.	31.5	44.	42.	33.
37	4	21.	0	0	0	0	6048.	126.	174.	169.	133.
41	1	5.	0	0	0	0	1512.	31.5	44.	42.	33.
46	13	68.	0	0	0	0	19656.	410.	566.	549.	432.
53	47	244.	0	0	0	0	71064.	1670.	2045.	1983.	1560.
54	8	42.	0	0	0	0	12096.	252.	348.	338.	266.

Cost of Corrective Actions by State

Cluster 14

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
11	1	0	0	0	0	0	0	0	0	0	0
12	16	0	0	0	0	0	0	0	0	0	0
14	202	0	0	0	0	0	0	0	0	0	0
21	1	0	0	0	0	0	0	0	0	0	0
22	1	0	0	0	0	0	0	0	0	0	0
38	2	0	0	0	0	0	0	0	0	0	0
47	13	0	0	0	0	0	0	0	0	0	0
57	31	0	0	0	0	0	0	0	0	0	0

Cost of Corrective Actions by State

Cluster 15

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
19	1	0	0	0	0	0	0	0	0	0	0
23	70	0	0	0	0	0	0	0	0	0	0
24	29	0	0	0	0	0	0	0	0	0	0
31	1	0	0	0	0	0	0	0	0	0	0
32	16	0	0	0	0	0	0	0	0	0	0
33	1	0	0	0	0	0	0	0	0	0	0
34	15	0	0	0	0	0	0	0	0	0	0
39	2	0	0	0	0	0	0	0	0	0	0
42	1	0	0	0	0	0	0	0	0	0	0
45	3	0	0	0	0	0	0	0	0	0	0
48	17	0	0	0	0	0	0	0	0	0	0
50	1	0	0	0	0	0	0	0	0	0	0
52	47	0	0	0	0	0	0	0	0	0	0
55	8	0	0	0	0	0	0	0	0	0	0
56	2	0	0	0	0	0	0	0	0	0	0
58	3	0	0	0	0	0	0	0	0	0	0

Cost of Corrective Actions by State

CLUSTER 16

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
11	4	0	0	0	0	0	0	0	0	0	0
12	5	0	0	0	0	0	0	0	0	0	0
14	20	0	0	0	0	0	0	0	0	0	0
22	17	0	0	0	0	0	0	0	0	0	0
38	2	0	0	0	0	0	0	0	0	0	0
47	16	0	0	0	0	0	0	0	0	0	0
57	17	0	0	0	0	0	0	0	0	0	0

Cost of Corrective Actions by State

Cluster 17

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
10	1	9.	0	0	0	1063.	3811.	287.	29.	60.	38.
16	1	9.	0	0	0	1063.	3811.	287.	29.	60.	38.
17	1	9.	0	0	0	1063.	3811.	287.	29.	60.	38.
19	20	180.	0	0	0	21262.	76228.	5730.	574.	1196.	762.
20	19	171.	0	0	0	20199.	72417.	5444.	545.	1136.	724.
23	93	837.	0	0	0	98868.	354460.	26645.	2669.	5561.	3543.
24	54	486.	0	0	0	57407.	205816.	15471.	1550.	3229.	2057.
27	13	117.	0	0	0	13820.	49548.	3725.	373.	777.	495.
30	8	72.	0	0	0	8505.	30491.	2292.	230.	478.	305.
31	42	378.	0	0	0	44650.	160079.	12033.	1205.	2512.	1600.
32	139	1251.	0	0	0	147771.	529785.	39824.	3989.	8312.	5296.
33	27	243.	0	0	0	28704.	102908.	7736.	775.	1615.	1029.
34	4	36.	0	0	0	4252.	15246.	1146.	115.	239.	152.
39	1	9.	0	0	0	1063.	3811.	287.	29.	60.	38.
40	82	738.	0	0	0	87174.	312535.	23493.	2353.	4904.	3124.
42	1	9.	0	0	0	1063.	3811.	287.	29.	60.	38.
43	15	135.	0	0	0	15947.	57171.	4298.	431.	897.	572.
45	94	846.	0	0	0	99931.	358272.	26931.	2698.	5621.	3581.
48	159	1431.	0	0	0	169033.	606013.	45554.	4563.	9508.	6058.
49	14	126.	0	0	0	14883.	53360.	4011.	402.	837.	533.
50	16	144.	0	0	0	17010.	60982.	4584.	459.	957.	610.
52	27	243.	0	0	0	28704.	102908.	7736.	775.	1615.	1029.
56	21	189.	0	0	0	22325.	80039.	6017.	603.	1256.	800.
58	5	45.	0	0	0	5316.	19057.	1433.	144.	299.	191.
59	5	45.	0	0	0	5316.	19057.	1433.	144.	299.	191.

Cost of Corrective Actions by State

Cluster 18

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
10	25	188.	0	0	0	63903.	78725.	6738.	560.	1210.	153.
16	54	405.	0	0	0	138029.	170046.	14553.	1210.	2614.	329.
17	1	8.	0	0	0	2556.	3149.	270.	22.	48.	6.
19	1	8.	0	0	0	2556.	3149.	270.	22.	48.	6.
20	4	30.	0	0	0	10224.	12596.	1078.	90.	968.	24.
23	33	248.	0	0	0	84351.	103917.	8894.	739.	1597.	201.
24	6	45.	0	0	0	15337.	18894.	1617.	134.	290.	37.
27	7	53.	0	0	0	17893.	22043.	1887.	157.	339.	43.
29	4	30.	0	0	0	10224.	12596.	1078.	90.	194.	24.
30	1	8.	0	0	0	2556.	3149.	270.	22.	48.	6.
31	60	450.	0	0	0	153366.	188940.	16170.	1344.	2904.	366.
32	18	135.	0	0	0	46010.	56682.	4851.	4032.	8712.	110.
33	15	113.	0	0	0	38342.	47235.	4043.	336.	726.	92.
34	3	23.	0	0	0	7668.	9447.	809.	67.	145.	18.
39	4	30.	0	0	0	10224.	12596.	1078.	90.	194.	24.
40	55	413.	0	0	0	140586.	173195.	14823.	1232.	2662.	336.
42	206	1545.	0	0	0	526557.	648694.	55517.	4614.	9970.	1257.
43	4	30.	0	0	0	10224.	12596.	1078.	90.	194.	24.
45	77	578.	0	0	0	196820.	242473.	20752.	1725.	3727.	470.
48	43	323.	0	0	0	109912.	135407.	11589.	963.	2081.	262.
49	6	45.	0	0	0	15337.	18894.	1617.	134.	290.	37.
50	2	15.	0	0	0	5112.	6298.	539.	45.	97.	12.
56	3	23.	0	0	0	7668.	9447.	809.	67.	145.	6.
59	37	278.	0	0	0	94576.	116513.	9972.	829.	1791.	226.

Cost of Corrective Actions by State

Cluster 19

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
12	7	0	38.	159.	63.	0	0	0	0	0	0
14	47	0	254.	1067.	423.	0	0	0	0	0	0
47	7	0	38.	159.	63.	0	0	0	0	0	0
57	9	0	49.	204.	81.	0	0	0	0	0	0

Cost of Corrective Actions by State

Cluster 20

Corrective Action											
			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
10	60	690.	55.	1362.	90.	0	0	0	0	0	0
16	8	92.	7.	182.	12.	0	0	0	0	0	0
17	4	46.	4.	91.	6.	0	0	0	0	0	0
19	5	58.	5.	114.	8.	0	0	0	0	0	0
20	47	541.	43.	1067.	71.	0	0	0	0	0	0
23	1	12.	1.	23.	2.	0	0	0	0	0	0
24	6	69.	6.	136.	9.	0	0	0	0	0	0
27	32	368.	29.	726.	48.	0	0	0	0	0	0
29	15	173.	14.	341.	23.	0	0	0	0	0	0
30	2	23.	2.	45.	3.	0	0	0	0	0	0
31	22	253.	20.	499.	33.	0	0	0	0	0	0
32	6	69.	6.	136.	9.	0	0	0	0	0	0
33	8	92.	7.	182.	12.	0	0	0	0	0	0

Cost of Corrective Actions by State

CLUSTER 20 Cont'd

Corrective Action			BULK TESTING						AIR QUANTIFICATION		
State Code	Number of School Distr. in State in Cluster	Inspection	Petrographic Microscopy	Electron Microscopy	X-Ray Diffraction	Encapsulation	Removal	Disposal	Air Monitoring (Sampling)	Lab Cost-Electron Microscopy	Lab Cost-Optical Microscopy
34	12	138.	11.	272.	18.	0	0	0	0	0	0
39	7	81.	6.	159.	11.	0	0	0	0	0	0
40	9	104.	8.	204.	14.	0	0	0	0	0	0
42	45	518.	41.	1022.	68.	0	0	0	0	0	0
43	15	173.	14.	341.	23.	0	0	0	0	0	0
45	21	242.	19.	477.	32.	0	0	0	0	0	0
48	8	92.	7.	182.	12.	0	0	0	0	0	0
50	8	92.	7.	182.	12.	0	0	0	0	0	0
55	1	12.	1.	23.	2.	0	0	0	0	0	0
56	7	81.	6.	159.	11.	0	0	0	0	0	0
58	2	23.	2.	45.	3.	0	0	0	0	0	0
59	21	242.	19.	477.	32.	0	0	0	0	0	0

APPENDIX C

Detailed Listings of Affected Schools and Students in the New York Public School System

APPENDIX C

DETAILED LISTINGS OF AFFECTED SCHOOLS AND STUDENTS IN THE NEW YORK CITY PUBLIC SCHOOL SYSTEM

New York City Schools Asbestos Task Force was officially organized in November 1978. This task force is responsible for the organization and execution of asbestos control for the five boroughs of New York City. This responsibility includes inspection of schools, bulk sampling, identification of the type of corrective action needed, development of a corrective action schedule, and selection and monitoring of contractors engaged to perform the asbestos corrective work.

The events that led to the formation of this task force began in 1977 when an asbestos problem caused school closings in New Jersey. The New York Board of Education began an assessment of the degree of asbestos hazard by reviewing building plans and specifications for asbestos materials in New York schools, and by conducting visual inspections. This survey was the basis of Phase One of its comprehensive asbestos control program. Phase One involved the removal of all materials suspected of containing asbestos in what were considered the twelve worst-case schools. The term suspected is used because laboratory tests were not made on bulk samples of the questionable material. As a result of this survey, which produced 185 suspect schools, and the work done in Phase One, the need for a long term unit to work on the asbestos problem was recognized.

In the remainder of this Appendix we discuss the city's asbestos abatement program, provide detailed listings of affected schools and students by school district, and finally discuss the financial implications of the program.

1. ASBESTOS ABATEMENT

The Task Force has developed an asbestos abatement program. The steps in the program are: inspection, bulk testing, identifying the corrective action for a situation, and continual monitoring of areas which were encapsulated or enclosed.

Sawyer's Algorithm is used as a guide when inspecting a building for the seriousness of the asbestos problem in areas with friable material. Whenever there is any indication that an area which contains asbestos which has not been corrected is deteriorating, another inspection is done. The inspectors have technical backgrounds and are knowledgeable in the use and appearance of asbestos-containing materials.

Bulk samples are taken from all materials suspected of containing asbestos. The potential friability of a material is considered to be as important as its current friable state. When a bulk sample is taken, it is divided into three parts. One is kept in the Office of the Task Force and the other two are sent to different laboratories for testing. The test identifies the number of asbestos fibers in the sample. By comparing the results from the two laboratories, more reliability can be placed on the results. There have been instances when the results reported by the laboratories varied greatly. When this occurs, a third laboratory test is done. Currently, New York City has approximately 500 samples on which results are pending.

When the results of the bulk sample are returned, Sawyer's asbestos algorithm is completed. The algorithm score indicates when an area will be corrected. The higher the algorithm score, the higher the priority and the sooner it will be corrected. This score, however, does not necessarily indicate how it will be corrected.

The decision of how an area will be corrected is based upon certain general rules of thumb. With some exceptions, areas that are judged to need removal are those that contain sprayed-on fireproofing, insulation, or acoustical materials. Areas exempt from removal are areas located behind dropped ceilings, and boiler and mechanical rooms. Mechanical and boiler rooms are the most difficult areas in which to remove or structurally contain materials. Most of the sprayed-on fireproofing and insulation located in these areas is encapsulated. These materials are generally very friable and the encapsulation material makes them very hard.

Hard acoustical plaster materials which are located in high activity areas (exits, cafeterias, shops, etc.) are generally enclosed with a physical barrier, generally sheet rock. Low activity areas with acoustical plaster (offices and libraries) are generally painted with two coats of approved sealer.

Areas where encapsulation and/or enclosure were used as a corrective measure are kept under periodic surveillance for deterioration. Surveillance is also necessary when work is done in that area. An Asbestos Program Form is published for all schools. The Form will indicate if there are any asbestos materials in the school and where they are located. A copy of each asbestos program form is placed in a main book and in the custodian's office. The custodian also uses an 'asbestos' stamp on each page of his sign-in book. This stamp indicates there are asbestos containing materials in the school.

In the areas where the asbestos is located, labels are placed which indicate that before any work commences in that area, the custodian should be notified.

Since it is difficult to visually recognize materials which have replaced asbestos containing materials in boiler rooms, sections where removal has taken place are painted blue.

2. DETAILED LISTINGS

Approximately 65 of the schools have had asbestos problems corrected. Another 120 schools may still need correction. This figure may change as there are a number of bulk sample results pending.

The following tables give detailed listings by school district of affected schools and students in the New York City Public School System.

The general location and number of the school districts are as follows:

- Manhattan, districts 1-6
- Brooklyn, districts 13-23, 32
- Bronx, districts 7-12
- Queens, districts 24-30
- Staten Island, district, 31
- High Schools, divided by borough, district 78.

Data on each affected school include affected square footage type of corrective action to be taken and the number of students affected. The number of affected students is the actual enrollment of that school. Square footage is based on estimates of the average size of affected areas. These averages are provided in a table following this page. The corrective action listed may be what is actually scheduled to be done or estimates based on general rules of thumb discussed above.

In instances, where bulk tests were pending, data were collected and placed in the potentially affected columns (right hand columns) of the detailed listings. Listed is information on potentially affected square feet, corrective action expected and number of students affected.

3. FINANCING NEW YORK CITY'S ASBESTOS CONTROL PROGRAM

The New York City Central School district's asbestos control program is funded through the local capital improvements budget. These are at present no outside funds used for corrective actions. Until FY1980, funds used in the program were reclassified from other programs in the budget. The funds for asbestos control were most often reclassified from the "Modernization and Construction" line item. In FY1980 asbestos control was given a separate line item entitled, "E-1891, Upgrading of Building Environment (Asbestos)".

In FY1980, $5 million was appropriated for asbestos control activities. The amount proposed for FY1981 is $2.8 million; for FY1982, $3.5 million; and for FY1983, $2.8 million. At the end of this period, it is anticipated that all necessary work will have been completed. The 1981, 1982, and 1983 proposed amounts for asbestos control action are, respectively, 2.1%, 2.1%, and 2.2% of the proposed total school system capital improvement budget.

AVERAGE SQUARE FOOTAGE OF ROOMS in NEW YORK CITY PUBLIC SCHOOLS

ROOMS	AVERAGE SQUARE FOOTAGE
Auditorium Ceilings	5000
Auditorium Walls (3)	2000
Band Room, Music Room	1500
Cafeteria (Teacher)	700
Cafeteria (Student)	4000
Classroom	700
Corridors	1500
Custodians Workshop	300
Dressing Room off Stage	200
Exits/Vestibuls	150
Gymnasium (Small)	3500
Kitchen	1500
Serving Area	150
Kindergarten	900
Library	1500
Lobby	700
Locker Room	1500
Medical Suite	700
Offices - Principal	400
- Secretary	200
- Custodians	300
Shops	1500
Sound Room	150
Store Rooms	350

School District: 1 **Borough:** Manhattan

School	ACTUAL Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	POTENTIAL Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-15			1500		1500	462			
P-19									
P-20		300		x	300	N/A			
P-22			1650	x	1650	896			
P-25									
P-34									
J-56									
J-60									
P-61									
P-63									
P-71									
P-97				x					
P-110									
P-137				x					
P-140									
P-142									
P-188									
Actual Total		300	3150		3450	1,358			
Total Students in District						12,064			

School District: 2 **Borough:** Manhattan

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-1									
P-2									
P-3		5000			5000	363			
P-6									
P-11				x					
J-17									
P-26									
P-33			2000		2000	430			
P-40									
P-41									
P-42									
P-51									
P-59									
J-65									
I-70									
J-104									
J-111									
J-114									
P-116									
P-124		300			300	840			
P-126									
P-130									
P-151									
P-167									
P-183									
P-190									
P-		5000			5000	511			
P									
P- Annex									
P 217									
Actual Tc -		10,300	2000		12,300	2144			
Total Students in District						20961			

School District: 3 **Borough:** Manhattan

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-9									
I-44									
J-54			1500		1500	N/A			
P-75									
P-76									
P-84									
P-87									
I-88									
P-113									
J-118		5000			5000	871			
P-144			1500		1500	N/A			
P-145									
P-149/207		5000			5000	339			
P-163									
P-165				x					
P-166									
P-179									
P-180									
P-185/208									
P-191		2200			2200	287			
P-199									
Actual Total		12,200	3000		15,200	1497			
Total Students in District						16,143			

School District: 4 **Borough:** Manhattan

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-7									
J-13									
I-45									
P-50									
P-57		150	8500		8650	706			
P-72									
P-83									
P-85(Vacant)									
P-96									
99									
P-101				x					
P-102									
P-108		14400	1500		15900	709			
P-109			1500	x	1500	423			
P-112/206		5000			5000	1023			
J-117									
P-121			1500	x	1500	610			
P-146									
P-155									
P-171									
Actual Total		19,550	13,000		32,550	3471			
Total Students in District						15,395			

School District: 5 Borough: Manhattan

School	ACTUAL						POTENTIAL		
	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
I-10/200									
P-30/31									
P-36									
J-43				x					
P-46		5000			5000	596			
P-79									
P-92		5000			5000	608			
P-123									
P-125				x					
P-129									
P-133									
P-154		5000			5000	692			
P-156									
P-161		5000	700		5700	757			
P-175									
P-197									
I-201				x					
I-136									
P-194			4000		4000	523			
I-195									
Actual Total		20,000	4700		24,700	3,176			
Total Students in District						14,047			

School District: 6 **Borough:** Manhattan

School	ACTUAL						POTENTIAL		
	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-28		5000			5000	1201			
J-52									
P-98									
P-115		5000			5000	1223			
P-128		5000			5000	1416			
P-132									
J-143									
P-152		5000		x	5000	1169			
P-153									
I-164									
P-173									
P-187				x					
P-189									
P-192		1500	1500		3000	1378			
Actual Total		21,500	1,500		23,000	6,387			
Total Students in District						19,622			

School District: 7 **Borough:** Bronx

School	ACTUAL						POTENTIAL		
	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-1									
P-5									
P-18									
P-18(old)									
P-25				x					
P-27				x					
P-29		5000	1400		6400	505			
P-30				x					
P-31				x					
P-40				x					
P-43									
P-49									
P-65									
P-124									
I-139									
I-149		5000	800		5800	918			
I-151									
P-154									
I-155									
P-156									
P-157		5900			5900	625			
P-161									
I-162				x					
I-183									
I-184									
Actual Total		15,900	2200		18,100	2,048			
Total Students in District						16,541			

School District: 8 **Borough:** Bronx

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-14									
P-36									
P-39				x					
P-48									
I-52									
P-60									
P-62									
P-69									
P-71									
P-72									
I-74									
P-75									
P-93									
P-100									
J-101									
P-107									
P-119									
J-120		5400	3000		8400	510			
J-123									
J-125		5000			5000	781			
P-130									
I-131		5000			5000	1483			
P-138									
P-140									
P-146									
P-152									
I-174									
P-182									
I-192									
Actual Total		15,400	3000		18,400	2,774			
Total Students in District						23,138			

School District: 9 **Borough:** Bronx

School	ACTUAL						POTENTIAL		
	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-2									
P-4			1500	x	1500	644			
P-11									
I-22		*		x					
P-28									
P-35				x					
P-42				x					
P-53				x					
P-55									
P-58				x					
P-63				x					
P-64									
P-70				x					
P-73									
I-82		1500			1500	1143			
P-88									
P-90				x					
P-104				x					
P-109									
P-110									
P-114									
P-126									
P-132		5000			5000	715			
I-145									
P-147									
I-148		5000			5000	1044			
P-163									
I-166									
P/I-229									
J-117									
Actual Total		11,500	1500		13,000	3546			
Total Students in District						31,650			

* Boiler Rooms and Pipes Only

School District: 10 **Borough:** Bronx

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-7				x					
P-8									
P-9/115 Ax									
P-24									
P-26		5000			5000	770			
P-32									
P-33									
J-45		7850	13250	x	21100	1297			
P-46									
P-56									
P-59									
P-79									
P/J-80				x					
P-81				x					
P-85									
P-86									
P-91		5000			5000	1430			
P-94				x					
P-95		5000			5000	1055			
J-115									
J-118									
P-122									
I-137									
J-141									
J-143				x					
P-205A									
P-205B									
Actual Total		22,850	13,250		36,100	4552			
Total Students in District						27979			

School District: 11 **Borough:** Bronx

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-15 (Closed)									
P-16									
P-19									
P-21									
P-41				x					
P-68									
P-76									
P-78									
P-83									
P-87									
P-89									
P-96									
P-97									
P-103									
P-105									
P-106									
P-108									
P-111				x					
P-112									
J-113									
P-121				x					
J-127									
J-135									
J-142									
I-144									
P-153		1500		x	1500	616			
P-160									
P-175									
P-178				x					
P-180		700	7000		7700	1039			
I-181									
Actual Total		2200	7000		9,200	1655			
Total Students in District						22,697			

School District: 12 * Borough: Bronx

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-6									
P-44									
P-47									
P-50									
P-57									
P-61									
P-66									
P-67									
P-77									
I-84									
P-92									
J-98									
P-99									
P-102									
I-116									
P-129/234									
P-150									
I-158									
I-167									
I-193									
P-198									
P-134									
J-136									
Total Students in District						16,693			

* No School Affected

School District: 13 **Borough:** Brooklyn

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-3									
P-8									
P-9			1500	x	1500	1368			
P-11									
P-20				x					
P-44			2700		2700	892	6111	700	6811
P-46			700		700	746			
P-54									
P-56									
P-67									
P-85									
P-93									
P-93Annex									
I-117									
P-133									
P-256									
I-258			4700		4700	1126			
J-265						1077	6100	10,400	16,500
P-270									
J-282									
P-287									
I/J-294			4000		4000	1206			
P-305									
P-307									
Actual Total			13,600		13,600	5338	12,211	11,100	23,311
Students Potentially Affected						1077			
Total Students in District						18707			

School District: 14 **Borough:** Brooklyn

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-16									
P-17				x					
P-18									
P-19									
P-19Annex									
P-23				x					
I-33									
P-34									
I-49									
J-50									
P-59		3300	8650		11,950	830			
I-71									
P-84				x					
P-110				x					
P-120									
P-122									
J-126									
P-132				x					
P-147									
P-157									
P-168									
P-196									
P-250									
P-257									
P-297		5000	1500		6500	725			
I-318									
Actual Total		8300	10,150		18,450	1555			
Total Students in District						20,350			

School District: 15 **Borough:** Brooklyn

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-1									
P-10									
P-15				x					
P-27				x					
P-29				x					
P-32		3650		x	3650	761			
P-38									
P-39									
P-51									
P-58									
J-88		5000		x	5000	1220			
P-94									
P-107									
P-124									
P-130									
P-131									
J-136				x					
J-142									
J-146									
P-154				x					
P-169									
P-172									
P-230									
P-261									
J-293									
P-321									
P-369									
Actual Total		8650			8650	1981			
Total Students in District						22,374			

School District: 16 **Borough:** Brooklyn

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-5									
P-21									
P-25									
P-26									
P-28									
J-35				x					
P-40									
P-57									
P-81									
P-243									
P-262									
P-304									
P-308									
P-309									
I-324									
P-335									
Total Students in District						12,152			

School District: 17 **Borough:** Brooklyn

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-42									
J-61						N/A		4700	4700
P-91									
P-92			1500		1500	1692			
P-138									
P-161									
P-167									
P-181									
P-189									
P-191									
I-210									
P-221									
P-241									
I-246				x		1690		4700	4700
P-249				x					
P-289									
P-289Annex									
P-316									
I-320			6000		6000	2080			
I-391									
P-397Annex									
P-398									
I-390									
Actual Total			7500		7500	3772		9400	9400
Students Potentially Affected						1690			
Total Students in District						25990			

School District: 18 **Borough:** Brooklyn

School	ACTUAL						POTENTIAL		
	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
J-68									
P-114									
P-115									
P-135									
P-208									
P-211			700	x	700	N/A			
P-219									
J-232									
P-233									
P-235									
P-242									
P-244									
J-252		5000	4000		9000	993			
J-252 Anx									
P-268									
P-272				x					
P-276									
P-279									
P-285									
Actual Total		5000	4700		9700	993			
Total Students in District						17204			

School District: 19 **Borough:** Brooklyn

School	ACTUAL						POTENTIAL		
	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-13									
P-63									
P-65									
P-72									
P-76									
P-108									
P-149									
P-158				x					
P-158Anx.									
P-159									
J-166				x					
P-I-171									
P-174									
P-190									
P-202									
P-213									
P-214									
P-218				x					
P-224				x					
P-260						626	2200	1500	3700
P-273						995	7200	5700	12,900
I-292									
I-302	235		1500		1785	1355		6400	6400
P-306							5000	4000	9000
P-328									
P-345									
P-346									
Actual Total	235		1500		1785	2976	14,400	17,600	32,000
Students Potentially Affected						11,621			
Total Students in District						24700			

School District: 20

Borough: Brooklyn

School	ACTUAL Removal Sq. Ft.	ACTUAL Encap. Sq. Ft.	ACTUAL Enclos. Sq. Ft.	ACTUAL Boilers & Pipes	ACTUAL Total Affected Sq. Ft.	ACTUAL Total Students	POTENTIAL Encap. Sq. Ft.	POTENTIAL Enclos. Sq. Ft.	POTENTIAL Total Affected Sq. Ft.
P-48									
J-62						1775		7200	7200
P-102						1055	5000		5000
P-104									
P105									
P-112									
P-118									
P-127									
P-140									
P-160									
P-163									
P-164									
P-170									
P-176									
P-179									
P-180									
P-185									
P-186									
P-192									
P-200									
J-201									
P-204						670	5000		5000
P-205									
J-220									
I-223									
I-227						1369	5000		5000
P-229									
P-247									
J-259						1178		1500	1500
							15,000	8700	23,700
Students Potentially Affected						6047			
Total Students in District						24,156			

School District: 21 **Borough:** Brooklyn

School	ACTUAL						POTENTIAL		
	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
J-43				x		1012	5000	1500	6500
P-90									
P-199						495		3700	3700
J-281									
P-288									
I-303									
P-329									
P-95									
I-96						1560	5000		5000
P-97									
P-99									
P-100									
P-101		5000			5000	790			
P-121									
P-128									
P-153									
P-177									
P-188									
P-209						614	5000		5000
P-212									
P-215									
P-216									
P-225									
P-226									
P-228						1152	5150		5150
P-238									
J-239						874		2000	2000
P-248									
P-253									
Actual Total		5000			5000	790	20150	7200	27350
Students Potentially Affected						5707			
Total Students in District						22,791			

School District: 22 **Borough:** Brooklyn

School	ACTUAL Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	POTENTIAL Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-14		1500			1500	1075	150		150
P-52						730	700	3000	3700
I-78									
P-89									
P-119									
P-134									
P-139									
P-152			2200	x	2200	1462			
P-193									
P-194						578	1500	3000	4500
P-195				x		401	1500	4300	5800
P-197									
P-198									
P-203						1007	5000		5000
P-206									
P-207						925	5000		5000
P-217									
P-222						944	5000		5000
J-234						1181	5000	1500	6500
P-236									
J-240									
P-251						764	6900	8300	15,200
P-254									
P-255						764	7200	6800	14,000
P-269						798	400	6500	6900
P-269 (Anx)				x					
P-277									
J-278						1192	2200	4000	6200
P-312									
Actual Total		1500	2200		3700	2537	40,550	37,400	77,950
Students Potentially Affected						9284			
Total Students in District						25,140			

School District: 23 **Borough:** Brooklyn

School	ACTUAL						POTENTIAL		
	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-41				x					
I-55									
P-73									
P-137									
P-150									
P-155									
P-156									
P-165									
P-175									
P-178									
P-183									
P-184									
I-263									
I-271			150		150	1741			
I-275									
P-284									
P-298									
P-327									
P-332									
P-396									
Actual Total			150		150	1741			
Total Students in District						14,062			

School District: 24 **Borough:** Queens

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-12									
P-13		1450			1450	1079			
P-14									
P-19									
P-49									
J-61									
P-68									
P-71				x					
J-73		5000	2200		7200	2051			
P-75									
P-81									
P-87									
P-88									
P-89									
P-91									
J-93		150	700		850	1136			
P-102									
P-113									
J-119		5000			5000	945			
J-125			700		700	1777			
P-128									
P-143									
P-153		5000			5000	583			
P-199		7200	8300		15,500	739			
P-229									
J-77									
Actual Total		23,800	11,900		35,700	8,310			
Total Students in District						24,470			

School District: 25 **Borough:** Queens

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-20		5000	3000	x	8000	1061			
P-22									
P-24									
P-29									
P-32									
P-79		5000			5000	841			
P-107									
P-120			3500		3500	837			
P-129									
P-154									
P-163									
P-164				x					
P-165			2200	x	2200	675			
P-168									
P-169									
P-184									
J-185									
J-189			2200		2200	1177			
P-193									
J-194									
P-200									
P-201									
P-209									
P-214									
J-218									
P-219		3300	3000	x	6300	583			
I-237									
P-21									
Actual Total		13,300	13,900		27,200	5,174			
Total Students in District						22,665			

School District: 26 **Borough:** Queens

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-18									
P-26			2900	x	2900	702			
P-31									
P-41									
P-46		5000			5000	245			
J-67									
I-74		12,900	18,200		31,100	801			
P-94									
P-98									
P-115		5000	2000	x	7000	426			
P-130									
P-133									
P-158		4000			4000	401			
P-162									
J-172									
P-173				x					
P-177			500		500	332			
P-178						316	6500	3800	10,300
P-179									
P-186									
P-188						404		3000	3000
P-191									
P-203									
P-205									
P-213									
J-216						1040	6500	5300	11,800
P-221									
187 P-159						404	6500	4500	11,000
Actual Total		26,900	23,600		50,500	2907	19,500	16,600	36,100
Students Potentially Affected						2164			
Total Students in District						13,962			

School District: 27 **Borough:** Queens

School	ACTUAL						POTENTIAL		
	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-42									
P-45				x					
P-47									
P-51									
I-53									
P-60									
P-62									
P-63									
P-64									
P-66									
P-90									
P-96									
P-97									
P-100									
P-104									
P-105									
P-106									
P-108									
P-114									
P-123									
P-124		5000			5000	651			
P-146									
P-155									
J-180									
P-183									
P-197			150	x	150	959			
J-198				x					
I-202									
P-207									
I-210			700		[illegible]0	1778			
P-215			1500		1500	924			
P-223									
P-225									
J-226									
P-232									
Actual Total		5000	2350		7350	4312			
Total Students in District						30,124			

School District: 28 **Borough:** Queens

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
I-8									
P-30									
P-40									
P-48									
P-50									
P-54									
P-55									
I-72									
P-80									
P-86									
P-99									
P-101									
P-117									
P-121									
P-139			2100		2100	473			
P-140									
I-142									
P-144									
J-157		5550	12,050	x	17,600	1241			
P-160									
P-174		5000		x	5000	564			
J-190		5000			5000	1153			
P-196									
P-206									
J-217		5000	3500		8500	1462			
P-220									
P-82									
Actual Total		20,550	17,650		38,200	4,893			
Total Students in District						21,332			

School District: 29 **Borough:** Queens

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-15									
P-33									
P-34				x					
P-35									
P-36									
P-37									
P-38		150			150	378			
P-52									
J-59									
P-95									
J-109		700			700	1591			
P-116									
P-118									
P-132									
P-134									
P-135									
P-136				x					
P-138									
P-147		5000	500		5500	952			
P-156									
P-176			800	x	800	527			
P-181									
I-192				x					
I-195									
I-231				x					
J-231									
I-238									
P-251									
Actual Total		5850	1300		7,150	3448			
Total Students in District						25,079			

School District: 30 **Borough:** Queens

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-2									
J-10									
P-11									
P-17			2000	x	2000	1734			
P-69									
P-70									
P-76			4000		4000	692			
P-84									
P-85				x					
P-92				x					
P-111		300		x	300	597			
P-112									
P-122									
I-126				x					
P-127									
J-141			1500		1500	1315			
J-145									
P-148									
P-149									
P-150		5000		x	5000	715			
P-151		5000			5000	861			
P-152		5000			5000	993			
P-166		5000			5000	1041			
P-171		5000			5000	711			
J-204									
I-227									
Actual Total		25,300	7,500		32,800	8,659			
Total Students in District						22,389			

School District: 31 **Borough:** Staten Island (Richmond)

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-1				x					
J-2									
P-3									
P-4				x					
P-5				x					
I-7									
P-8									
P-11									
P-13				x					
P-14									
P-15									
P-16									
P-19									
P-20									
P-21				x					
I-22									
P-23				x					
I-24		700	500		1200	1703			
P-25									
P-26				x					
I-27		5700	1500		7200	1085			
P-28									
P-29		3000		x	3000	674			
P-30				x					
P-31				x					
P-32									
I-34		2000			2000	1126			
P-35									
P-36(old)									
P-36 (new)									
P-38				x					
P-39									
P-40				x					
P-41									
P-42									
P-44									
P-45		5000			5000	658			

School District: 31 **Borough:** Staten Island

School	ACTUAL						POTENTIAL		
	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
P-46		40	700		740	314			
P-48									
J-49									
P-50									
J-51				x					
P-52									
P-53									
P-54			300		300	845			
P-55									
P-57									
P-60									
I-61									
P-69									
I-72									
P-18									
Actual Total		16,440	2,000		19,440	6,405			
Total Students in District						36,217			

School District: 32*

Borough: Brooklyn

School	ACTUAL Removal Sq. Ft.	ACTUAL Encap. Sq. Ft.	ACTUAL Enclos. Sq. Ft.	ACTUAL Boilers & Pipes	ACTUAL Total Affected Sq. Ft.	ACTUAL Total Students	POTENTIAL Encap. Sq. Ft.	POTENTIAL Enclos. Sq. Ft.	POTENTIAL Total Affected Sq. Ft.
P-45									
P-75									
P-86									
P-106									
I-111									
P-116									
P-123									
P-145									
P-151									
J-162									
P-274									
P-274(Anx)									
I-291									
J-296									
P-299									
P-377									
I-383									
P-384									

* No Schools Affected

School District: 78 **Borough:** Bronx

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
Bronx HS Sci.		5150			5150	3320			
Dewitt Clinton									
Grace Dodge									
J.F. Kennedy									
H.H. Lehman			700		700	3408			
James Monroe									
Morris		400			400	2849			
Morris (Anx)									
T. Roosevelt									
A.E. Smith		5000		x	5000	N/A			
S.Bronx HS									
A.Stevenson		1500	600		2100	4461			
H.S.Truman									
Walton HS				x					
C. Columbus									
Evander Childes									
Jane Addams				x					
S. Gompers									
Wm. Taft									
Roberta Clements									
Satellite Academy									
Actual Total		12,050	1300		13,350	14,038			
Total Students in District						48,695			

School District: 78 **Borough:** Brooklyn

	ACTUAL						POTENTIAL		
School	**Removal Sq. Ft.**	**Encap. Sq. Ft.**	**Enclos. Sq. Ft.**	**Boilers & Pipes**	**Total Affected Sq. Ft.**	**Total Students**	**Encap. Sq. Ft.**	**Enclos. Sq. Ft.**	**Total Affected Sq. Ft.**
Bay Ridge									
Boys & Girls									
Boys HS (old)									
Brooklyn Tech									
Bushwick		3000			3000	2952			
Canarsie									
J. Dewey		4000		x	4000	3422	4500		4500
E. NY Voc.			2000		2000	N/A			
Erasmus Hall						4077	400	3000	3400
W Grady		5000			5000	N/A			
John Jay				x					
T. Jefferson			1650		1650	3928			
Lafayette				x		3495		4200	4200
F. K. Lane				x					
A. Lincoln				x					
J Madison			2350		2350	3275			
E.R. Murrow									
Prospect Heights									
FD Roosevelt									
Sheepshead Bay			4000		4000	3117			
S. Shore		1500		x	1500	4586			
S.J. Tilden		5000			5000	2952			
New Uretch				x					
G. Westinghouse		150		x	150	N/A			
Voc. Tech.									

School District: 78 **Borough:** Brooklyn

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
Prod. Ctr.									
E. Whitney						N/A	700	6000	6700
G. Wingate		1550	24000		25,550	3459			
Bay Ridge Annex									
Ft. Hamilton									
Midwood		5000	6200		11,200				
Alex. Hamilton				x					
Clara Barton									
Eastern Dist.									
Girls HS (Old)									
Sara Hale									
City As School									
Ebbets Field School									
Pacific HS									
PM HS									
W. Murrow						27,691			
Actual Total		25,200	40,200		65,400	3,45	5,600	13,200	18,800
Potentially Affected Students						7,572			
Total Students in District						87,371			

School District: 78 **Borough:** Manhattan

School	ACTUAL						POTENTIAL		
	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
HS Art & Design									
L.D. Brandeis		450		x	450	4219			
B. Franklin									
Chas. Hughes				x					
ML King									
J. Richman			3000	x	3000	3543			
Seward Park									
Stuyvesant									
G. Washington			250	x	250	3298			
M.D. Bacon				x					
Washington Irving		2200	4700		6900	2397			
Bergtraum									
Chelsea									
LaGuardia			700		700	2503			
School of Perf. Arts									
Maritime Trades									
Voc. Tech.									
Brandeis (Anx)									
Bacon (Anx)									
Norman Thomas									
Park East									
Seward Park (Anx)									
Actual Total		2650	8650		11,300	15,960			
Total Students in District						39,502			

School District: 78 **Borough:** Queens

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
J. Adams									
Bayside						3718	5000		5000
Beach Channel									
J. Browne		150	2650		2800	3849			
B. Cardozo									
B. Cleveland						N/A	5000		5000
T. Edison						N/A		850	850
Far Rockaway		5000			5000	2265			
Flushing						2741	1500	10850	12350
Forest Hills									
Hillcrest									
A. Jackson									
Jamaica									
Jamaica(old)									
F. Lewis									
Long Island City						3297		700	700
Newtown						4680		4000	4000
Richmond Hill									
Springfield Gardens									
M. VanBuren		1500		x	1500	3425			
A. Martin						2035		6100	6100
Queens Voc.									
Richmond Hill (Anex)									
WC Bryant						3844		1400	1400
Actual Total		6650	2650		9300	29,854	11,500	23,900	35,400
Students Potentially Affected						24,380			
Total Students in District						65587			

School District: 78 **Borough:** Staten Island (Richmond)

	ACTUAL						POTENTIAL		
School	Removal Sq. Ft.	Encap. Sq. Ft.	Enclos. Sq. Ft.	Boilers & Pipes	Total Affected Sq. Ft.	Total Students	Encap. Sq. Ft.	Enclos. Sq. Ft.	Total Affected Sq. Ft.
Curtis									
New Dorp						2801	5000		5000
Port. Richmond				x		2982	1500		1500
Tottenville									
S. Wagner						3032	2100		2100
McKee Voc.		5000			5000	N/A			
Actual Total		5000			5000		8600		8600
Students Potentially Affected						8815			
Total Students in District						16,065			

APPENDIX D

Data Collection Instruments

ARTHUR YOUNG & COMPANY

1025 CONNECTICUT AVENUE N.W.
WASHINGTON, D.C. 20036

LETTER SENT TO SUPERINTENDENTS OF SCHOOL DISTRICTS THAT HAD RESPONDED TO THE EPA VOLUNTARY SURVEY

The Environmental Protection Agency (EPA) has identified low-level non-industrial exposure to friable asbestos as potentially hazardous. Based on a preliminary survey of States in 1978, EPA feels that the potential for this type of exposure may be widespread in schools. In response to a law suit by the Environmental Defense Fund in May 1979, EPA has decided to develop a regulation that would require primary and secondary schools to take certain measures to control asbestos exposure in their buildings. Arthur Young & Company has been contracted by EPA to develop estimates of the number of students and staff potentially exposed to friable asbestos and estimates of cost and other negative economic impacts of protective measures against asbestos in primary and secondary schools.

Based on a review of available data sources, including the results of a recent EPA survey to which you responded, we have determined that direct contact with the school districts is necessary to meet the data requirements of this project. We have selected a sample of school districts from which to obtain the required data. This sample was randomly chosen from certain classifications of school districts that responded to the above mentioned EPA survey.

In conducting this study we feel that its success, and the reliability of its results are strongly dependent upon information provided by this sample of school districts. Your school district is one of those selected in this sample. We are, therefore, requesting your valuable assistance in providing accurate estimates of the negative economic impacts of this regulation as identified below.

In a separate letter addressed to the building maintenance chief in your district (see Attachment), we have requested that he assess the friable asbestos exposure potential in buildings in your school district. He is also requested to provide figures on the number (or percentage) of buildings requiring certain types of corrective actions.

We would appreciate it if you could coordinate the efforts of the maintenance chief with yours, to provide us with an indication of potential negative impacts of performing the corrective actions within your district.

Specifically, it would be helpful if you could use the results of the maintenance chief's assessment to determine the magnitude of potential negative impacts in your district's schools. Information on the following negative impacts in your school district is desired:

- Number of schools or parts of schools that may temporarily close and the number of schools day that could be lost as a result of any required asbestos correction activity.
- Number of schools or parts of schools that may permanently close, the number of students displaced, and the expected change in average class size and student/teacher ratio at your other schools due to these possible closings.
- The number of jobs that could be lost if the asbestos problem is considered severe enough by your maintenance chief's assessment to warrant either a long-term temporary school closing or permanent school closing.
- Any additional indirect costs (ie. over and above the direct cost of asbestos control).

We would appreciate receiving your responses by December 19, 1979. We are confident that by using estimates developed by school district officials, such as yourselves, the validity and eventual usefulness of the study results will be increased. Also, it would be advantageous to the school districts to provide early notice to EPA of any areas where severe impacts or dislocations are possible. The agency's regulatory strategy could be affected by such early, pre-proposal findings. We will be contacting you and your maintenance chief in the next few weeks to answer any questions you may have.

We would greatly appreciate any help you are able to provide us on this study and look forward to working with you towards its success. If you have any questions or suggestions, please do not hesitate to call Mr. Philip Mathias at (202) 828-7000. In his absence you can call Steve Schoepke or Susan Wright at the same telephone number.

Very truly yours,

ARTHUR YOUNG & COMPANY

By: ______________________

Dimitri A. Plionis
Principal

ARTHUR YOUNG & COMPANY

1025 CONNECTICUT AVENUE N.W.
WASHINGTON, D.C. 20036

LETTER SENT TO THE MAINTENANCE PERSONNEL OF SCHOOL DISTRICTS THAT HAD RESPONDED TO THE EPA VOLUNTARY SURVEY

The Environmental Protection Agency (EPA) has identified low-level non-industrial exposure to friable asbestos as potentially hazardous. Based on a preliminary survey of States in 1978, EPA feels that the potential for this type of exposure may be widespread in schools. In response to a law suit by the Evironmental Defense Fund in May 1979, EPA has decided to develop a regulation that would require primary and secondary schools to take certain measures to control asbestos exposure in their buildings. Arthur Young & Company has been contracted by EPA to develop estimates of the number of students and staff potentially exposed to friable asbestos and estimates of cost and other negative economic impacts of protective measures against asbestos in primary and secondary schools.

In its proposed regulation, EPA is considering the use of a procedure called the "Asbestos Exposure Assessment Algorithm", a copy of which is attached, to determine the corrective action required. The Asbestos Exposure Assessment Algorithm is designed to provide an indication of the extent or degree of an asbestos condition. To score an area, it is necessary to judge and score eight factors: 1) the condition of the asbestos material; 2) the presence of water damage; 3) the percentage of exposed surface area; 4) the accessibility of the asbestos area to students; 5) the student or other activity levels and movement; 6) the level of air plenum or direct air stream on the asbestos; 7) the friability of the asbestos and; 8) the asbestos content.

Based on a review of available data sources, we have determined that direct contact with the school districts is necessary to meet the data requirements of this project. We have selected a sample of school districts from which to obtain the required data. This sample was randomly chosen from certain classifications of school districts.

Your school district has been selected in our sample. We are, therefore, requesting you to kindly assist us in our efforts on this important project by applying the "Asbestos Exposure Assessment Algorithm" to your school buildings.

After you have completed the assessment of buildings in your district, you can obtain, based on the attached documentation, an indication of either: the percentage of buildings in the district requiring corrective action, by type of action; or the number of buildings requiring each type of corrective action. Your participation in this study would consist of a numerical presentation of the results of that assessment. For example, after reviewing conditions in your school buildings, you may have found that seventy-five out of 100 schools require "inspection", ten require "encapulation", five require "removal," and twenty require "deferred action" (see attachment for details). We would need these numbers or percentages such as: 75%-inspection, 10%-encapulation, 5%-removal, and 20%-deferred action.

We sincerely feel that it will be to your school district's advantage to review asbestos conditions in your school buildings at this time. First it will allow you to assess the magnitude of the potential hazard, if any, for your district. Second, you will be able to assess your situation using a specific procedure that is currently recommended by EPA, and determine in advance any corrective measures that may be necessary to comply with a future EPA asbestos regulation.

The result of the assessment of asbestos exposure in your district must be received no later than December 21, 1979. We recognize that this schedule is quite restrictive; but because of EPA's intended regulation schedule, we must begin the analysis phase of the study at that time. We also recognize, though, the importance of your particular school district's input to the final results of the study. Because of this, our staff will be in contact with you in about one week to assist with any questions you may have.

We appreciate any help you are able to give us on this project and look forward to your participation in it. If there are any questions or suggestions relevant to this matter, please do not hesitate to call Philip Mathias at (202) 828-7000. In his absence, you can call Steve Schoepke or Susan Wright at the same telephone number.

Very truly yours,

ARTHUR YOUNG & COMPANY

By:__________________________
Dimitri A. Plionis
Principal

ARTHUR YOUNG & COMPANY

1025 CONNECTICUT AVENUE N.W.
WASHINGTON D.C. 20036

LETTER SENT TO SUPERINTENDENTS OF SCHOOL DISTRICTS THAT HAD NOT RESPONDED TO THE EPA VOLUNTARY SURVEY

The Environmental Protection Agency (EPA) has identified low-level non-industrial exposure to friable asbestos as potentially hazardous. Based on a preliminary survey of States in 1978, EPA feels that the potential for this type of exposure may be widespread in schools. In response to a law suit by the Environmental Defense Fund in May 1979, EPA has decided to develop a regulation that would require primary and secondary schools to take certain measures to control asbestos exposure in their buildings. Arthur Young & Company has been contracted by EPA to develop estimates of the number of students and staff potentially exposed to friable asbestos and estimates of cost and other negative economic impacts of protective measures against asbestos in primary and secondary schools.

Based on a review of available data sources, we have determined that direct contact with the school districts is necessary to meet the data requirements of this project. We have selected a sample of school districts from which to obtain the required data. This sample was randomly chosen from certain classifications of school districts.

In conducting this study we feel that its success, and the reliability of its results are strongly dependent upon information provided by this sample of school districts. Your school district is one of those selected in this sample. We are, therefore, requesting your valuable assistance in providing accurate estimates of the negative economic impacts of this regulation as identified below.

In a separate letter addressed to the building maintenance chief in your district (see Attachment), we have requested that he assess the friable asbestos exposure potential in buildings in your school district. He is also requested to provide figures on the number (or percentage) of buildings requiring certain types of corrective actions.

We would appreciate it if you could coordinate the efforts of the maintenance chief with yours, to provide us with an indication of potential negative impacts of performing the corrective actions within your district.

Specifically, it would be helpful if you could use the results of the maintenance chief's assessment to determine the magnitude of potential negative impacts in your district's schools. Information on the following negative impacts in your school district is desired:

- Number of schools or parts of schools that may temporarily close and the number of schools day that could be lost as a result of any required asbestos correction activity.
- Number of schools or parts of schools that may permanently close, the number of students displaced, and the expected change in average class size and student/teacher ratio at your other schools due to these possible closings.
- The number of jobs that could be lost if the asbestos problem is considered severe enough by your maintenance chief's assessment to warrant either a long-term temporary school closing or permanent school closing.
- Any additional indirect costs (ie. over and above the direct cost of asbestos control).

We would appreciate receiving your responses by December 21, 1979. We are confident that by using estimates developed by school district officials, such as yourselves, the validity and eventual usefulness of the study results will be increased. Also, it would be advantageous to the school districts to provide early notice to EPA of any areas where severe impacts or dislocations are possible. The agency's regulatory strategy could be affected by such early, pre-proposal findings. We will be contacting you and your maintenance chief in the next few weeks to answer any questions you may have.

We would greatly appreciate any help you are able to provide us on this study and look forward to working with you towards its success. If you have any questions or suggestions, please do not hesitate to call Mr. Philip Mathias at (202) 828-7000. In his absence you can call Steve Schoepke or Susan Wright at the same telephone number.

Very truly yours,

ARTHUR YOUNG & COMPANY

By:____________________

Dimitri A. Plionis
Principal

ARTHUR YOUNG & COMPANY

1025 CONNECTICUT AVENUE N W
WASHINGTON D C 20036

LETTER SENT TO THE MAINTENANCE PERSONNEL OF SCHOOL DISTRICTS THAT HAD NOT RESPONDED TO THE EPA VOLUNTARY SURVEY

The Environmental Protection Agency (EPA) has identified low-level non-industrial exposure to friable asbestos as potentially hazardous. Based on a preliminary survey of States in 1978, EPA feels that the potential for this type of exposure may be widespread in schools. In response to a law suit by the Evironmental Defense Fund in May 1979, EPA has decided to develop a regulation that would require primary and secondary schools to take certain measures to control asbestos exposure in their buildings. Arthur Young & Company has been contracted by EPA to develop estimates of the number of students and staff potentially exposed to friable asbestos and estimates of cost and other negative economic impacts of protective measures against asbestos in primary and recovery schools.

In its proposed regulation, EPA is considering the use of a procedure called the "Asbestos Exposure Assessment Algorithm", a copy of which is attached, to determine the corrective action required. The Asbestos Exposure Assessment Algorithm is designed to provide an indication of the extent or degree of an asbestos condition. To score an area, it is necessary to judge and score eight factors: 1) the condition of the asbestos material; 2) the presence of water damage; 3) the percentage of exposed surface area; 4) the accessibility of the asbestos area to students; 5) the student or other activity levels and movement; 6) the level of air plenum or direct air stream on the asbestos; 7) the friability of the asbestos and; 8) the asbestos content.

Based on a review of available data sources, including the results of a recent EPA survey, to which you have responded, we have determined that direct contact with the school districts is necessary to meet the data requirements of this project. We have selected a sample of school districts from which to obtain the required data. This sample was randomly chosen from certain classifications of school districts that responded to the above mentioned EPA survey.

Your school district has been selected in our sample. We are, therefore, requesting you to kindly assist us in our efforts on this important project by applying the "Asbestos Exposure Assessment Algorithm" to your school buildings.

After you have completed the assessment of buildings in your district, you can obtain, based on the attached documentation, an indication of either: the percentage of buildings in the district requiring corrective action, by type of action; or the number of buildings requiring each type of corrective action. Your participation in this study would consist of a numerical presentation of the results of that assessment. For example, after reviewing conditions in your school buildings, you may have found that seventy-five out of 100 schools require "inspection", ten require "encapslation", five require "removal," and twenty require "deferred action" (see attachment for details). We would need these numbers or percentages such as: 75%-inspection, 10%-encapulation, 5%-removal, and 20%-deferred action.

We feel that your efforts on this matter should be greatly facilitated by your previous work on the above mentioned EPA survey. Information you developed for your response to that survey should provide the majority of the data required to complete the algorithm(s) for your district. Also, we sincerely feel that it will be to your school district's advantage to review asbestos conditions in your school buildings at this time. First it will allow you to assess the magnitude of the potential hazard, if any, for your district. Second, you will be able to assess your situation using a specific procedure that is currently recommended by EPA, and determine in advance any corrective measures that may be necessary to comply with a future EPA asbestos regulation.

The result of the assessment of asbestos exposure in your district must be received no later than December 19, 1979. We recognize that this schedule is quite restrictive; but because of EPA's intended regulation schedule, we must begin the analysis phase of the study at that time. We also recognize, though, the importance of your particular school district's input to the final results of the study. Because of this, our staff will be in contact with you in about one week to assist with any questions you may have.

We appreciate any help you are able to give us on this project and look forward to your participation in it. If there are any questions or suggestions relevant to this matter, please do not hesitate to call Philip Mathias at (202) 828-7000. In his absence, you can call Steve Schoepke or Susan Wright at the same telephone number.

Very truly yours,

ARTHUR YOUNG & COMPANY

By:______________________
D. Plionis
Principal

Tracor Jitco

Tracor Jitco, Inc.
1776 East Jefferson Street
Rockville, Maryland 20852
Telephone 301 881-2305

LETTERS SENT TO LABORATORIES AND CONTRACTORS

November 1, 1979

Tracor Jitco, Inc., is under contract with the Environmental Protection Agency to determine the economic impact of regulations to control asbestos exposures in school buildings. As part of this cost impact study, we will be providing the EPA with a list of laboratories and contractors who are available to provide services relating to this asbestos problem.

In order to be included on the EPA list of contractors available to provide services, please submit the name, address and telephone number of a person who may be contacted along with the appropriate unit cost (per sample, per square foot, per hour, etc.) and subcosts, if applicable, of each of the following services that you perform:

1. Bulk sample analysis by:
   a. polarized light microscopy
   b. x-ray diffraction
   c. electron microscopy
2. In-school air sampling
3. Air sample filter analysis by:
   a. OSHA optical microscopy method
   b. electron microscopy
4. Removal (EPA, OSHA approved methods)
5. Encapsulation (EPA, OSHA approved method)
6. Enclosure (EPA, OSHA approved method)
7. Disposal (EPA approved method)
8. Marking of areas containing asbestos

Please mail your reply no later than November 13. A self-addressed, stamped envelope is enclosed for your convenience.

Sincerely,

Joseph J. Beres
Industrial Hygienist

JJB:dp

Enclosure

Tracor Jitco

Tracor Jitco, Inc.
1776 East Jefferson Street
Rockville, Maryland 20852
Telephone 301 881-2305

LETTER SENT TO THE MAINTENANCE PERSONNEL OF SCHOOL DISTRICTS THAT HAD NOT RESPONDED TO THE EPA VOLUNTARY SURVEY

October 24, 1979

Dear :

Tracor Jitco, Inc., is under contract with the Environmental Protection Agency to assist in determining the economic impact of regulations concerning the handling of asbestos in schools. Part of this economic impact relates to inspection, testing, removal and other activities being conducted by school districts. You would be of great assistance to the success of this program by providing as much of the following information as possible:

1. Names and addresses of schools surveyed for asbestos.
2. Number of students in each school surveyed.
3. Square footage of each school surveyed.
4. Amount of time spent surveying at each school.
5. Hourly rate of person performing survey.

If a school or schools had bulk samples analyzed by polarized light microscopy, please provide:

6. Names, addresses, and phone numbers of laboratories providing this service.
7. Cost of analysis per sample.

If removal, encapsulation, or enclosure of asbestos was performed,

8. Type of service and name, address, and phone number of contractor(s) performing this service.

Please mail your reply by Monday, November 5 using the self-addressed, stamped envelope provided for your convenience.

Sincerely,

Joseph J. Beres
Industrial Hygienist

JJB:wpc

Enclosure

Tracor Jitco

Tracor Jitco, Inc.
1776 East Jefferson Street
Rockville, Maryland 20852
Telephone 301 881-2305

LETTER SENT TO EPA REGIONAL ASBESTOS
COORDINATORS, OSHA AND NIOSH PERSONNEL

October 30, 1979

Dear :

Tracor Jitco, Inc., is under contract with EPA to determine the economic impact of its regulations on controlling asbestos in schools. We are accomplishing this by contacting EPA Regional Asbestos Coordinators, OSHA and NIOSH personnel, school superintendents and contractors for information.

One of the objects of our cost impact study is to determine the regional availability as well as the cost of the following services:

1. Bulk sample analysis
2. Air monitoring surveys
3. Air filter sample analysis
4. Removal of asbestos
5. Disposal
6. Enclosure
7. Encapsulation

If you are aware of any laboratories and contractors that provide these services, please send us the names, addresses and phone numbers of as many as possible. Any information you may have regarding marking costs will be of great value.

I am enclosing a self-addressed, stamped envelope for your use. Thank you for your cooperation.

Sincerely,

Joseph J. Beres
Industrial Hygienist

JJB:dp

Enclosure

APPENDIX E

Draft Asbestos Exposure Assessment Algorithm

Only the scores indicated can be assigned to a factor. For example, "1", "3", and "4" are not acceptable scores for Factor I: Material Condition. The scores have been intentionally weighted to reflect severity of the individual factors effect on exposure potential.

The area to be evaluated should be any part of the school where the factors remain uniform. For example, an auditorium with both an inaccessibile ceiling surface in the stage area and a very accessible and damaged surface in the audience area constitutes two different areas. The scores for the two areas may exhibit a wide variation in scale number, a different assessment, and possibly different corrective actions.

Step 2: Exposure Number Calculation

The Exposure Number is derived from the Factor Scores by a formula. After entering the chosen Factor Scores on lines 1 through 8 of Table II:

a. Sum factors 1 through 6 and enter opposite SUM;
b. Multiply Factor 7 times factor 8, and enter opposite PRODUCT;
c. Multiply SUM times PRODUCT.and enter opposite EXPOSURE NUMBER.

This number represents the result of your assessment for each area of the building. The Exposure Number must now be compared to the Corrective Action Scale, which is Step 3.

Step 3: Comparison of Exposure Number to Corrective Action Scale

Table III, Corrective Action Scale, presents four types of corrective action, a brief description of each, and a range of Exposure Numbers for which that Corrective Action is appropriate. Compare the Exposure Number derived in Step 2 to the ranges in Table III to determine whether action is needed. For example, an Exposure Number of 90 clearly indicates that the asbestos should be removed. An Exposure Number of 10, however, might suggest encapsulation or deferral of action. In this case it is necessary to further analyze the situation, perhaps to consider factors such as the length of time that action could be deferred or development of a management plan which would significantly reduce potential exposure.

Table 1: Factor Description and Scores

FACTOR ONE. CONDITION OF MATERIAL:

The condition of the asbestos materials may indicate the possibility of fibers being released to the area(i.e. contamination) and the potential for future fiber release. An assessment of the condition depends upon a combination of the

ASBESTOS EXPOSURE ASSESSMENT

ALGORITHM

There are three steps in applying the guide: (1) the eight factors are assigned a numerical value corresponding to their proper description; (2) the numerical values are combined by a mathematical formula to produce the Exposure Number; and (3) the Exposure Number is compared to the Corrective Action Scale. These three steps should be performed for each area of the building in which asbestos has been found. The three steps of the exposure guide are described below.

Step 1: Factor Score Selection

Table I presents a list of the eight factors, a brief description of the range or extent to which a particular condition applies, and a numerical "Factor Score" corresponding to that description. The official making the assessment must first select the description best fitting the situation in that area.

quality of the installation, adhesion of the material to the underlying substrate, deterioration, vandalism and/or damage. This factor is comprised of three levels:

A. NO DAMAGE: material is intact and shows no signs of deterioration. SCORE 0.

B. MODERATE DAMAGE: Visual inspection and physical contact indicate that the material is breaking up into layers or beginning to come loose from the substrate. There may be small areas (less than 10% of the total area) where the material is deteriorating. There may be signs of accidental or intentional damage. SCORE 2

C. SEVERE DAMAGE: The material is non-cohesive. Pieces are disloged and debris in the area is evident. Parts of the material may be hanging from the ceilings or may have fallen to the floor. Inspect for severe accidental or intentional damage SCORE 5.

FACTOR TWO: WATER DAMAGE

Water can dislodge, delaminate, and disturb friable asbestos materials that are otherwise in good condition. Water can carry fibers as a slurry to other areas where evaporation will leave a collection of fibers that can become reentrained (resuspended) in the air. This factor is comprised of three levels:

A. NO WATER DAMAGE: No water stains or evidence of the material being disturbed by water. No stains or buckling on the floor, ceiling or walls to indicate past water damage. SCORE 0

B. MINOR WATER DAMAGE: Small areas of the material or adjacent floor and/or walls show water stains and ceiling material may be slightly buckled. However, pieces have not fallen from the ceiling and the damage affects 10 percent or less of the material. SCORE 1

C. MODERATE TO MAJOR WATER DAMAGE: Water has dislodged some of the material and caused the material to break away, or become saturated with the potential to fall.

and/or

More than 10 percent of the material has been affected. SCORE 2.

FACTOR THREE: EXPOSED SURFACE AREA

The exposed surface area of friable material has an effect on potential fiber fallout levels and the possibility for contact and damage. A useful criterion for determining the amount of exposed material is whether the friable material is visible.

Asbestos material above a suspended ceiling is not considered exposed unless: (1) the ceiling panels are removed for regular maintenance, (2) the panels are damaged (i.e. due to vandalism, or maintenance) (3) the space above the ceiling comprises an air plenum.

Areas with louvers, grids, or other open ceiling systems should be considered exposed. This factor is comprised of three levels:

A. MATERIAL NOT EXPOSED: (For example, all asbestos materials are contained behind a solid suspended ceiling which is very hard to open and shows no sign of damage. The plenum is not used for air conveyance.) SCORE 0

B. TEN PERCENT OR LESS OF THE MATERIAL IS EXPOSED:(a susbended ceiling is opended occassionally or has damaged or missing panels, for example) SCORE 1

C. GREATER THAN 10 PERCENT OF THE MATERIAL IS EXPOSED: SCORE 4

FACTOR FOUR: ACCESSIBILITY

If the asbestos material can be reached, it is accessible and subject to accidental or intentional contact and damage. Material which is accessible (within reach) is most likely to be disturbed in the future either by accident or intentionally and, therefore, this factor is one of the most important indicators of exposure potential.

The proximity of the friable material to heating, ventilation, lighting, and plumbing systems requiring maintenance or repair indicates accessibility.

Also, the behavior of the student population should be considered in evaluating accessibility. For example, students involved in sport activities may accidently cause damage to the material on the walls and ceilings of gymnasiums. Material that is easily accessible is also subject to damage by vandalism. The presence of damage is the most obvious indicator for accessibility.

This factor is comprised of three levels:

A. NOT ACCESSIBLE: The material is located above a suspended ceiling or is concealed by ducts or piping. The building occupants cannot contact the material. Maintenance is not required for the ducts, piping or electrical systems near the asbestos materials SCORE 0.

B. RARELY ACCESSIBLE: The material is contacted only during abnormal activity such as infrequent maintenance or repair. Building occupants rarely touch the material or throw objects against it. SCORE 1.

C. ACCESSIBLE: Material is contacted frequently due to routine maintenance and/or the building occupants can contact the material during normal activity, (during this activity occupants could touch and dislodge the material or easily throw objects against it.) SCORE 4.

FACTOR FIVE. ACTIVITY AND MOVEMENT

This factor combines the effects of general causes that may result in contact or damage to friable material. These causes include air movement, building vibration from machinery or any other source, and activity levels of students or building workers. This factor is also an indication of future exposure potential. This factor is comprised of three levels:

A. NONE OR LOW ACTIVITY: In areas such as administrative offices, libraries, some classrooms, rarely used storage rooms, and fire exists. The population is quiet and non-destructive. SCORE 0

B. MODERATE ACTIVITY: Activities that could create regular vibration in cafeterias, corridors, classrooms or other areas. This vibration could result in fibers being released from the material to the immediate area. SCORE 1

C. HIGH ACTIVITY LEVEL: Occupants in cafeterias and corridors are vandalous or disruptive in their activities. Also,all gymnasiums and rooms containing machinery are subject to high vibration and air movement levels. Areas ajacent to very high sources of vibration (highways, engine shops, etc.) should be scored as "high activity level" SCORE 2

FACTOR SIX. AIR PLENUM OR DIRECT AIR STREAM

Friable asbestos-containing material within an air plenum or in an air stream if undisturbed, has a low potential of contaminating the building's environment. However, it must be considered since contamination may result from contact or damage during maintenance, repairs, renovations, or if the air stream is very turbulent. This factor is comprised of two levels:

A. NO AIR PLENUM OR DIRECT AIR STREAM PRESENT: SCORE 0.

B. AIR PLENUM OR DIRECT AIR STREAM PRESENT: SCORE 1.

An air plenum exists when the return (or, in rare cases, conditioned) air leaves a room or hall through vents in a suspended ceiling and travels at low speed and pressure through the space between the actual ceiling and the suspended ceiling. For the purpose of scoring this factor, a plenum is present if asbestos material is also found in that space. A direct air stream is present when ducts for the heating or air conditioning system blow directly on asbestos material.

FACTOR SEVEN. FRIABILITY

The term friable is applied to material that can be crumbled, pulverized, or reduced to powder in the hand. In order to score the material in question it must be touched. The asbestos-containing material can vary in degree of friability. The more friable the material, the greater the potential for asbestos fiber release and contamination. Sprayed asbestos material is generally more friable that most trowelled materials. This factor is comprised of these levels:

A. LOW FRIABILITY: material that is difficult yet possible to damage by hand. This would include most "trowelled" materials and manufactured items such as very soft ceiling tiles. SCORE 1

B. MODERATE FRIABILITY: Fairly easy to dislodge and crush or pulverize by hand. Material may be removed in small or large pieces. SCORE 2

C. HIGH FRIABILITY: The material is fluffy, spongy, or flaking and may have pieces hanging down. SCORE 3

FACTOR EIGHT: ASBESTOS CONTENT

The percentage for all types of asbestos present in a given sample should be added for the total asbestos content. While all asbestos materials present an exposure potential, those with a high percentage of asbestos can release more fibers. This factor is comprised of three levels:

A. TRACE AMOUNTS TO ONE PERCENT: SCORE 0.

B. ONE PERCENT TO FIFTY PERCENT: SCORE 2.

C. FIFTY PERCENT PLUS: SCORE 3.

These levels of asbestos content must be derived from results of bulk sample analysis. Building records or assumptions are not reliable or acceptable

Table II. Exposure Number Calculation

Factor	Factor Score
1. Material Condition	
2. Water Damage	+
3. Exposed Surface Area	+
4. Accessibility	+
5. Activity and Movement	+
6. Air Plenum	+ ______
SUM [1 + 2 + 3 + 4 + 5 + 6]	=
7. Percent Content	
8. Friability	x ______
PRODUCT [7 x 8]	=
Exposure Number = PRODUCT x SUM	= ______

Table III. Corrective Action Scale

EXPOSURE NUMBER RANGE	CORRECTIVE ACTION
0 - 12	DEFERRED ACTION
Advantage:	There is no direct cost associated
Disadvantages:	(1) The potential for exposure may increase. (2) A management system is required. Precautions are necessary to prevent damage during maintenance or renovation. (3) It is necessary to have continous inspection and reevaluation.
When Appropriate:	When there is negligible exposure potential.
When Inappropriate:	(1) When there is definite or questionable exposure potential. (2) Continuing inspection is doubtful
10-50	ENCAPSULATION
Advantage:	(1) It controls fiber release (2) It is a rapid and economical method
Disadvantages:	(1) The asbestos source remains. (2) If the material is damaged or deteriorating the additional weight of the sealant may cause layers of the material to break away from the underlying surface. (3) A management system is required. Precautions are necessary to prevent damage during maintence or renovation. (4) Continuing inspection and maintenance for damage or deterioration to

encapsulated surface. (i.e. future potential for fiber release is possible).

(5) Encapsulated material is very difficult to remove if it becomes necessary.

When Appropriate:

(1) When removal is not feasible

(2) The material still retains bonding integrity.

(3) Damage to the material is not probable.

(4) Accessibility to material is limited

(5) The surface in question is complex (i.e. pipes, lines and ducts).

(6) When economic or time constraints are present.

When Inappropriate:

(1) When removal is feasible

(2) Material does not adhere well to the substrate. The weight of the sealant may cause futher damage.

(3) When the material is deteriorating or damaged.

(4) Damage to the material is probable

(5) Water damage or the potential for water damage is evident.

(6) High accessibility present

(7) When continuing inspection and maintenance of encapsulated material is doubtful.

10-50

ENCLOSURE

Advantage:

(1) It controls fiber release

(2) May be the most rapid, economical and uncomplicated method.

Disadvantage: (1) The asbestos source remains

(2) Fiber fall out continues behind the enclosure

(3) Maybe costly if enclosure disturbs functions of other systems (e.g. enclosure may require lighting changes).

(4) Management system required. Precautions necessary for entry into enclosure for maintenance or renovation.

(5) Continuing inspection and maintenance of damage to enclosure system required.

When Appropriate: (1) Removal is not feasible.

(2) Disturbance or entry into enclosed area is not likely.

(3) Economic constraints are present

When Inappropriate: (1) Removal is feasible

(2) Damaged or deteriorating material causes high level of fiber fallout.

(3) Water damage to enclosure is likely

(4) Entry into enclosure probable for repairs and maintenance.

REMOVAL

40 and over

Advantage: (1) It eliminates the asbestos source

(2) Ends the exposure and precludes the development of future problems.

Disadvantages: (1) Usually the most costly, complicated and time consuming method.

(2) Replacement with substitute material may be necessary.

(3) Higher potential for worker exposure during removal

When Appropriate:

(1) High exposure exsists

(2) Material is deteriorating, high accessible and has severe water damage.

(3) Open material surfaces.

When Inappropriate:

(1) When removal is not feasible because of cost, location of material and kind of surface to which material has been applied (e.g. removal of material from complex surfaces such as pipes, lines and ducts).

Summary:

(1) If exposure number is 0-12 usually can defer action.

(2) If exposure number is approximately 40 or over removal is probably the best corrective action.

(3) If the exposure number is 10-50 and has high water damage or accessibility factor, removal is probable the best corrective procedure.

(4) If the exposure number is 10-50 and the water damage and accessibility factors are low, then the constraints (i.e. economic, time and complicated surfaces) need to be examined. The three corrective actions possible are incapsulation, enclosure and removal.

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